Bulletin of the American Ceramic Society

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical and Scientific Questions and Promotion of Co-operative Research

Volume 4, 1925

Edited by the Secretary of the Society, Ross C. Purdy
Assistant Editor, Emily C. Van Schoick
Assisted by Officers of the Industrial Divisions

Lacking No. 12 V. 4
Written for Feb 10, 1926

BULLETIN
of the
American Ceramic Society

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific and Art Questions and Promotion of Coöperative Research

V. 4
Nos 1–12
Jan–Dec
1925

Vol. 4 | **January, 1925** | **No. 1**

EDITORIALS

A NEW YEAR'S GREETING

This issue of the *Journal* is the first of the twenty-seventh annual publication of the Society. The character and value of this and of the succeeding volumes is for the members of the Society to determine. Twenty-six volumes are now beyond improving. They will continue being a source of inspiration and information but their character is determined.

We have no better or more valuable New Year's greetings than an earnest hope that the printed records of the Society shall be of increasing value in each succeeding year.

CERAMIC EDUCATION

It is of importance to the ceramic industries that ten universities in America are providing laboratories, classrooms and instructors for the purpose of creating and transmitting information on ceramic technology. The ceramic art schools have contributed to the welfare of industrial ceramics or their maintenance has not been worth while. There have been fairly large financial outlays for buildings, equipment and materials and, of more importance, a large amount of human endeavor and personal expenditures of time and money to make these schools successful.

Has all of this been worth while? Are the results tangible, concrete and creditable? Would less specific and more general educational courses in ceramic technology accomplish more, less, or as much?

Such questioning as this is worth while for either the ceramic industries should give the ceramic school appreciative support or they should advise discontinuance of the schools. These schools are supported by taxation. The ceramic industries pay their share of this support, hence their interest in the schools lies in both the cost and in the production of the schools.

There are many very capable collegiate trained technologists employed in ceramics who are not products of ceramic schools. There are very discerning managers of ceramic plants who have a preference for technical men other than graduates of ceramic schools and the service rendered has apparently justified this preference.

Facts are not disputable and the facts are that graduates of our ceramic schools have a justified demand for their services and this demand is increasing. The ceramic schools are serving a good purpose. They may not be giving the training most needed or which would be most effective but they certainly are fulfilling their purpose in the best way they know how. It is the duty of the industrialist to make known the manner in which the ceramic schools can more effectively serve the industries.

The service rendered by the ceramic schools is not the same as that rendered by the federal and state institutions. There is some overlapping but just enough to make solid and firm the whole American scheme of ceramic research and education. And this is true in the relations between the schools, the press and the associations. Each has its part and each has played its part.

This is the 30th Anniversary of the beginning of collegiate training in ceramic technology. This occasion should be of interest to every ceramist. This interest is national. No one school or organization is more interested than another and no association more than any other. THE AMERICAN CERAMIC SOCIETY, the national pooling of all technical ceramic interest, representing the industries, the schools, the federal and state organizations and the press, will give opportunity to fittingly celebrate this Anniversary the week of February 16. This will be an occasion for a frank exposé of our entire scheme for ceramic education and research.

ACTIVITIES OF THE SOCIETY

NEW MEMBERS RECEIVED FROM NOVEMBER 15 TO DECEMBER 15

Donald J. Andrews, 220 E. Second St., East Liverpool, Ohio. Secretary, The American Porcelain Co.

James M. Boyd, 16 Melbourne Road, Norwalk, Conn. Vice-President, Twiggs County Kaolin Co.

Marion K. Burr, 39 W. 9th Ave., Columbus, Ohio. Student.

G. Roger Coats, 610 Wesley Bldg., Philadelphia, Pa. Sales Engineer, F. J. Ryan & Co.

Frederick C. Henderson, 356 — 14th Ave., Columbus, Ohio. Student.

William L. Hurdman, 7 High St., Pensnett, Dudley, Worcestershire, England. Research Ceramic Chemist, Associated Enamelers, Ltd.

Charles L. Jones, Box 47, Swissvale, Pa. Chemical Engineer, Vesuvius Crucible Co.

F. A. McCann, Mellon Institute, Pittsburgh, Pa.

Cornelis J. van Nieuwenburg, RotterdamscheWeg, Delft, Holland. Professor in Analytical Chemistry of Delft Technical University.

Louis A. Snider, Box 604, Weirton, W. Va. Superintendent, Brick Masonry Department, Weirton Steel Co.

F. J. Sutphen, 2605 Central Ave., Middletown, Ohio. American Rolling Mill Co.

Society Boosters' Record

	Personal
Robert F. Ferguson	1
George A. Forbes	1
Robert E. Gould	1
R. D. Landrum	1
H. W. Mauser, Jr.	1
E. W. Tillotson	1
Office	5
Total	11

BALTIMORE-WASHINGTON SECTION MEETING

Thirty-two members and guests attended the meeting of the Baltimore-Washington Section held on November 22, 1924, at the Old Colony Club in the Emerson Hotel, Baltimore, Md. A dinner was served after which election of officers was held. The members elected to serve for the coming year are:

Herbert Insley, *Chairman,* Bur. of Standards, Washington, D. C.

Frank G. Roberts, *Vice-chairman,* Porcelain Enameling and Manufacturing Co., Baltimore, Md.

Reardon Fusselbaugh, *Secy. and Treas.,* Porcelain Enamel and Novelty Co., Baltimore, Md.

B. T. Sweely, *Councillor,* Baltimore Enamel and Novelty Co., Baltimore, Md.

An able and interesting paper on "Glass House Practice" by Clarence McComas of the Carr-Lowrey Glass Co. of Baltimore was presented. Mr. McComas went into the detail in explaining the use of the pot and continuous furnaces, the ills and remedies

of these two processes. Those of the members interested in glass expressed gratefulness for a wealth of information and a discussion of some few minutes ensued.

Stephen Leach, of the Locke Insulator Corporation, Baltimore, Md., gave an excellent paper on "China Clay." The section agreed that if there was anything about the formation, mining, preparation and uses of English china clay which were not touched upon by Mr. Leach, such things were unknown altogether. Mr. Leach was extended individual and collective appreciation for the interesting and thorough manner in which he dealt with his subject.

SOCIETY BOOSTERS FOR 1924

Olaf Andersen. Kristiania, Denmark. Member, AMERICAN CERAMIC SOCIETY, 1918—. Abstractor.

R. J. Anderson *Bull.*, **3** [1], 11. Abstractor.

ROBERT H. ARMSTRONG

R. H. Armstrong. Born Alfred, N. Y., 1900. B.S., Ceramic Engineering, Alfred Univ., 1922. Member, AMERICAN CERAMIC SOCIETY, 1923—. With Fiske and Co., Inc., summers of 1920 and 1921 and from 1922 to July, 1924. Present location, Alfred, N. Y. Contribution: "Some Unavoidable Heat Losses in the Use of Periodic Systems," *Journal*, June, p. 423.

Howard C. Arnold. B.S., Ceramics, Univ. of Illinois, 1914; M.A., 1916, Physical and Optical Mineralogy. Instructor, Ceramic Engineering, Univ. of Ill., 1916–17. First Lieut., Research Division, Chemical Warfare Service, U. S. A., 1917–19. Chief Chemist, B. F. Drakenfeld & Co., N. Y. City, 1919–21. Ceramic Engineer, Arthur D. Little Inc., Cambridge, Mass., 1921 to date. Member, AMERICAN CERAMIC SOCIETY, 1920—. Office: Comm. on Education, Enamel Division.

George Aurien. Supt., Mississippi Glass Co. Member, AMERICAN CERAMIC SOCIETY, 1921—. Office: Comm. on Standards (Tests, Glass Division).

E. E. Ayars. *Bull.*, **3** [3], 100. Office: Editor, Question Box, Refractories Division. Contribution: "Firing Resistance in a Round, Down-draft Kiln Equipped with a Mechanical Stoker," *Journal*, December, p. 889.

Richard F. Bach. Formerly curator, instructor and executive secretary, Columbia University, School of Architecture. Taught history of architecture ornament, decorative arts, painting and sculpture. Library Avery Architectural Library. Associate Editor of *Good Furniture Magazine*. Regular contributor to art magazines, trade journals, year books. Since 1919 Extension Secretary of the American Foundation of Arts. Since 1918, Associate in Industrial Arts, Metropolitan Museum of Art. Contribution: "Art in Industry," *Bulletin*, August, p. 277.

Arthur E. Baggs. *Bull.*, **3** [1], 13. Office: Comm. on Rules, Art Division; Comm. on Divisions and Sections; Chairman, New England Section.

C. E. Bales. *Bull.*, **3** [1], 13. Office: Abstractor. Vice-chairman, Refractories Division.

L. E. Barringer. *Jour.*, **6** [1], 41. Office: Comm. on Publications; Associate Editor, *Journal;* Comm. on Education, Whitewares Division.

NOTE: Where pictures and biographical sketches of contributors to the *Journal* and workers for the SOCIETY have been published previously, a reference is made to this sketch followed by the contribution made in 1924.

G. E. Barton. *Bull.*, **3** [4], 131. Office: Chairman, Glass Division; Comm. on Divisions and Sections.

F. E. Bausch. *Bull.*, **3** [1], 13. Office: Chairman, St. Louis Section.

H. C. Beasley. Gen. Supt., Coonley Mfg. Co., Cicero, Ill. Member, AMERICAN CERAMIC SOCIETY, 1920—. Office: Councillor, Enamel Division. Chairman, Chicago Section. Comm. on Divisions and Sections.

M. F. Beecher. Born, Mason City, Ia., April, 1887. B.S., Ceramics, 1910; Cer. Engineering, 1915, Iowa State College. Experience in stoneware plant and brick yard, Iowa Engineering Expt. Station. Research Laboratories, Norton Company, Worcester, Mass. Member, AMERICAN CERAMIC SOCIETY, 1910—. Offices: Trustee, one term. For 1924: Comm. on Papers and Definitions, Refractories Division. Comm. on Standards (Definitions). Directed publication of laboratory paper from Norton Co., "Studies on the Thermal Conductivities of Some Refractory Materials," *Journal*, January, p. 19.

LEO A. BEHRENDT

Leo A. Behrendt. Born, Chicago, Ill., May, 1894. Short course in ceramics, Univ. of Ill. Laboratory Assistant, Midland Terra Cotta Co., 1911–22. Supervised, mining and shipping of clay and coal, Chicago Terra Cotta Companies, 1922–24. Maintenance engineer and supervisor over raw materials, Midland Terra Cotta Co., 1924 to date. Member, AMERICAN CERAMIC SOCIETY, 1916—. Contribution: "Mining of Indiana Clay for Terra Cotta," *Bulletin*, September, p. 331.

E. C. BINGHAM

M. L. Bell. *Bull.*, **3** [1], 14. Office: Comm. on Research, Refractories Division.

Eugene C. Bingham. Born, Cornwall, Vt., December, 1878. A.B. degree, Middlebury College, 1899. Ph.D., Johns Hopkins Univ., 1905. Student Leipzig, Berlin and Cambridge (England), 1906. Member: American Chemical Society, A. S. T. M., A. A. A. S., Metric Assn., Amer. Assn. of Univ. Professors. Prof., Chemistry, Richmond College, 1906–15. U. S. Bureau of Standards, 1915–16. Lafayette College, 1916 to date. Contributions: "Plasticity as a Means for Control of Properties," *Journal*, June, p. 430. "Discussion on Plasticity," *Bulletin*, October, p. 375.

C. F. Binns. *Jour.*, **6** [1], 23. Office: Comm. on Standards (Tests) Art Division.

Marion Worthington Blair. Born Brazil, Ind., 1878. Rose Polytechnic Inst., 1903. M.E. degree, Rose Polytech., 1913. Construction engineer and assistant superintendent, Terre Haute Vitrified Brick Co., 1903–05. Plant construction and general consulting work, also in charge technical bureau National Paving

MARION W. BLAIR

Brick Mfrs. Assn., including investigation and standardization of Rattler Test for Paving Brick, specifs. for which are used through the U. S. and England, 1905–11. Design, construction and operation of plants manufacturing paving brick, face brick and hollow ware. Also developed complete system of method and process for manufacture of promenade and quarry tile (*Trans. Amer. Ceram. Soc.*, **19**, 361(1917)). Supt. in charge of operation and construction, Murphysboro Paving Brick Co., and H. & R. Mining and Mfg. Co. Work included complete electrification of Murphysboro plant and construction of a modern plant at East St. Louis, 1921–24. Engineer in charge of St. Louis territory for Manufacturers' Equipment Co., Dayton, Ohio, 1924 to date. Member, AMERICAN CERAMIC SOCIETY, 1914—. Contribution: "Elimination of Waste in Heavy Clay Products Industry," *Bulletin*, February, p. 56.

H. H. Blau. Born, Dayton, Ohio, May, 1897. B.S., Chem. Eng., Carnegie Inst. Tech., 1919. S.M. Physical Chemistry, Mass. Inst. Tech., 1920. Computer for Miami Conservancy District, Dayton, Ohio, 1917. Macbeth-Evans Co., Charleroi, Pa., 1920 to date. Contribution: "Note on Early Optical Glass Making in the U. S.," *Journal*, May, p. 322.

A. V. Bleininger. *Jour.*, **6** [1], 24. Office: Comm. on Divisions and Sections; Comm. on Research.

C. A. Bloomfield. *Jour.*, **5** [7], 66; *Jour.*, **6** [1], 87. Councillor, Eastern (New Jersey) Section.

George A. Bole. *Jour.*, **5** [11], 333; *Jour.*, **6** [1], 154. Office: Comm. on Contact, Heavy Clay Products Division; Comm. on Standards (Tests), Refractories Division. Contributions: Co-author with F. G. Jackson, "The Oxidation of Ceramic Ware during Firing. I. Some Reactions of a Well-Known Fire Clay," *Journal*, March, p. 163. Co-author with R. T. Stull, "Utilization of Georgia Kaolins in the Manufacture of Face Brick," *Journal*, May, p. 347.

M. C. BOOZE

Macdonald C. Booze. Born, Bethany, Ill., December, 1892. B.S., Ceramics, Univ. of Illinois, 1915. Supt., Medal Paving Brick Co., Wooster, Ohio, 1915–17. Ceramic Engineer, U. S. Bur. Mines, Ceramic Expt. Station, Columbus, Ohio, 1917–19. In charge of Ceramic Division, Research Laboratories, Norton Co., Worcester, Mass., 1919–23. Senior Fellow, Refractories Manufacturers Assn. Fellowship, 1923 to date. Member, AMERICAN CERAMIC SOCIETY, 1916—. Office: Comm. on Standards (Raw Materials), Refractories Division. Comm. on Coöperation. Representative Comm. E-1 A. S. T. M. Contributions: Co-author with F. C. Flint, "Checker Brick for Resisting Alkali Slags," *Journal*, August, p. 594. "Fire Clay Brick for the Open Hearth," *Journal*, September, 686.

J. C. Boudreau. *Bull.*, **3** [1], 14. Office: Comm. on Education, Art Division.

N. L. BOWEN

Norman L. Bowen. Born, Kingston, Ont., June, 1887. M.A., Queen's Univ., 1907; B.S., Queen's, 1909; Ph.D., Mass. Inst. Tech., 1912. Geological field work for Ontario Bur. Mines and Geol. Surv. of Canada, 1907–12. Petrologist, Geophysical Labora-

tory, 1917–18. Optical Glass Investigation, 1917–18. Prof. of Mineralogy, Queen's Univ., 1918–20. Petrologist, Geophysical Lab., 1920 to date. Member, Geol. Soc. Amer., Wash. Acad. Sci., Amer. Acad. Arts and Sci., Amer. Geophys. Union. Contribution: Co-author with J. W. Greig, "The System Al_2O_3–SiO_2," *Journal*, April, p. 238.

DAVIS BROWN

Davis Brown. Born, near Portland, Ind., August, 1860. Normal and night school for drawing and designing. Experience as machinist, sales engineer, shop supt., designing and manufacturing clay working machinery for the past thirty-five years. Now chief engineer, The Hadfield-Penfield Steel Co., Bucyrus, Ohio. Member, AMERICAN CERAMIC SOCIETY, 1918—. A. S. M. E. Contribution: "Combating Laminations and Improving the Brick Structure," *Journal*, April, p. 174.

R. P. BROWN

G. H. Brown. *Jour.*, **5** [7], 63; *Jour.*, **6** [1], 41. Secretary, Eastern (New Jersey) Section.

Richard P. Brown. Born, Philadelphia, Pa., September, 1884. Penn Charter School and Drexel Inst. Member, AMERICAN CERAMIC SOCIETY, 1915—. Also A.S.M.E., A.I.E.E., A.S.T.M., Amer. Electrochem. Soc., A.I.M.M.E. President, Brown Instrument Co., Philadelphia, Pa. Contribution: "Pyrometry—Past and Present," *Journal*, August, p. 620.

• **W. F. Brown.** *Bull.*, **3** [1], 15. Office: Comm. on Standards (Tests), Glass Division.

W. K. Brownlee. Born, Wellsburgh, W. Va., 1867. Early experience in brick yards, glass furnace and glass factory construction, the latter with Nichols and Mathews. Supt. of furnace and construction work, Libbey Glass Co., Toledo, Ohio, 1900. Founded Buckeye Clay Pot Co., 1909. President and General Mgr. of this Company. President, Farber Fire Brick Co., Farber, Mo. Has been instrumental in developing continuous railroad tunnel kilns for fire brick to a high degree of economy and efficiency. Member, AMERICAN CERAMIC SOCIETY, 1921—. Contribution: "Insulation of Glass Tanks," *Journal*, June, 457.

W. K. BROWNLEE

JOHN F. BYRNE

P. P. Budnikoff. *Bull.*, **3** [1], 15. Contribution: "Comparison of Methods of Analysis of Gypsum," *Journal*, November, p. 817.

E. N. Bunting. *Bull.*, **3** [1], 16. Abstractor.

G. K. Burgess. *Jour.*, **6** [6], 191. Office: Councillor, Heavy Clay Products Division.

John F. Byrne. Born, Chicago, Ill., 1899. Univ. of Pittsburgh. B.S., Metallurgy, Univ. of Utah, M.S.,

MARGARET K. CABLE

Carnegie Inst. Tech. American Smelting and Refining Co., Garfield, Utah. Research Fellow, Carnegie Inst. Tech. Research on coal problems, U. S. Bureau of Mines, Pittsburgh Expt. Station, 1922 to date. Member, Amer. Chem. Soc. Contribution: Co-author with J. D. Davis, "An Adiabatic Method of Studying Spontaneous Heating of Coal," *Journal*, November, p. 809.

Margaret K. Cable. Born, Crookston, Minn. Worked in pottery at Handicraft Guild, Minneapolis. Studied with F. H. Rhead at St. Louis School of Ceramics, 1911. Later with Prof. C. F. Binns, Alfred Univ. Since 1910, Instructor in Ceramics, Univ. of N. Dak., Grand Forks, N. D. Made Asst. Prof. of Ceramics in School of Mines of Univ. of N. D. Investigative work on the high grade pottery clays of N. Dak. Member: AMERICAN CERAMIC SOCIETY, 1913—. Office: Vice-chairman, Art Division. Contribution: "Glazes and Indian Designs on North Dakota Pottery," *Journal*. June, p. 489.

HORACE H. CLARK

H. D. Callahan. Employed, Northwestern Terra Cotta Co., Chicago, Ill. Member, AMERICAN CERAMIC SOCIETY, 1920—. Office: Comm. on Contact, Terra Cotta Division.

R. L. Clare. *Jour.*, **6** [1], 56. Office: Associate Editor, *Journal*. Trustee, Terra Cotta Division.

H. H. Clark. Born, Chicago, Illinois, July, 1885. M.E., Mo. School of Mines, 1905. Consulting engineer on problems connected with industrial fuels and furnaces. Member, AMERICAN CERAMIC SOCIETY, 1921—. Contribution: "Gas as a Fuel for Vitreous Enameling," *Journal*, August, p. 643.

W. M. Clark. *Jour.*, **6** [6], 58. Abstractor. Office: Chairman, Comm. on Research, Glass Division.

Willi M. Cohn. Born, Berlin, June, 1897. Technische Hochschule, Danzig. Technische Hoch., Berlin. Dipl. Ingenieur. Dr. Ing. Managing director, the Kishon Clay Works, Ltd., Haifa, Palestine. Member, Verein Deutscher Ing., German Ceramic Society. Contribution: "The Problem of Heat Economy in the Ceramic Industry," *Journal*, May, p. 359; June, p. 475; July, p. 548.

S. S. COLE

Sandford S. Cole. Born, Cuba, N. Y., 1900. B.S., Ceramics, Alfred Univ., 1923. Industrial Fellow, Mellon Inst. with Koppers Co., in charge of research on silica and clay refractories and standardization of the same for use in coke and gas oven construction. Member, AMERICAN CERAMIC SOCIETY, 1922—. Office: Abstractor.

Raymond D. Cooke. Born, Fond du Lac, Wis., December, 1890. B.S. (Chemistry), Univ. of Wis., 1913. M.S., Univ. of Wis., 1914. Chemist, Armour & Co., Chicago, 1914–17. Fellow Mellon Inst., Enameling

Fellowship, 1917–23. Supt., Enamel Dept., Columbian Enameling and Stamping Co., Terre Haute, Ind., 1913 to date. Member, AMERICAN CERAMIC SOCIETY, 1917—. Office: Representative, Comm. on Nominations, Enamel Division. Comm. on Papers and Program. Editor, Question Box. Comm. on Standards (Tests). Coöperative Comm. on Fish-Scale Research. Contributions: "The Effect of Furnace Atmosphere on the Firing of Enamel," *Journal*, April, p. 277. "The Plastic Properties of Enamel Slip," *Journal*, September, p. 651.

R. D. COOKE

Sidney Cornell. Born, Derby, Conn., October, 1887. Stevens Inst. of Tech. Prof. Engineer, Univ. State of N. Y. Carnegie Steel Co., Duquesne Works Laboratory. Technical Assistant and Lubricant Inspector, 1907–12. As Secy., Pittsburgh Section, Amer. Electrochem. Soc. made trip to Europe on elec. furnaces, 1912. Efficiency Eng., Pittsburgh Crucible Steel Co., 1913. Chem. Engr., Griscom Russell Co., 1914. Efficiency Engr. and Supt. of Heat Treating, Remington Arts UMC Co., 1914–17. Captain Ordnance, U. S. A., 1917–19. Consulting Chem. and Indus. Mgr., 1919—. Contribution: "Some Considerations Necessary in Selection of Refractories for the Open Hearth," *Journal*, September, p. 670.

SIDNEY CORNELL

Paul E. Cox. *Jour.*, **6** [1], 105. Office: Comm. on Research, Art Division. Comm. on Papers and Program. Contributions: "A Study of Plasticity by Practical Potters' Methods," *Journal*, March, p. 151. "A Ceramic Decorative Process Suitable for Public School Use," *Journal*, July, p. 511.

Charles W. Crane. *Bull.*, **3** [1], 16. Office: Chairman, Eastern (New Jersey) Section. Comm. on Divisions and Sections.

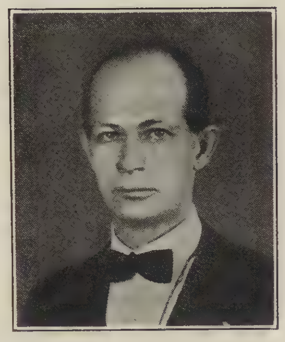
J. L. Crawford. *Bull.*, **3** [1], 17. Office: Comm. on Coöperation, Refractories Division.

J. W. Cruikshank. Born, London, England. Consulting Engr., 1901–17, design and construction of glass factories. Work for foreign plate glass mfgrs. Captain, U. S. Engrs. during World War. Incorporated J. W. Cruikshank Engineering Co., 1917. Member, Engrs. Soc. W. Pa., Soc. Amer. Military Engrs., Soc. Glass Tech. (English). AMERICAN CERAMIC SOCIETY, 1920–24. Corporation member, 1924—. Office: Chairman, Pittsburgh Section. Comm. on Divisions and Sections, Glass Division.

T. S. Curtis. Pres. Vitrefrax Co., Los Angeles, Calif. Member, AMERICAN CERAMIC SOCIETY, 1922—. Office: Secretary, California Section.

R. R. Danielson. *Jour.*, **6** [1], 52. Offices: Chairman and Trustee, Enamel Division. Comm. on Research. Comm. on Divisions and Sections. Associate Editor, *Journal*. Abstractor. Contributions: Co-author with T. D. Hartshorn and W. N. Harrison, "Factors Affecting the Warpage of Sheet Iron and Steel in Enameling," *Journal*, May, p. 326.

J. W. CRUIKSHANK



J. D. DAVIS

J. D. Davis. Born, Middleport, Ohio, April, 1882. B.A., Ohio State Univ., 1905. Grad. work in George Washington Univ. and Univ. of Pittsburgh. Chemist, Columbus Iron and Steel Co. (6 months). Chemist, Lowe Bros. Paint Co., Dayton, Ohio (2 years). Chemist, U. S. Geol. Surv., Washington, D. C. (2 years). Chemist, U. S. Bur. Mines (14 years). Fuel chemist, U. S. Bur. Mines, Pittsburgh Expt. Sta. to date. Member: Amer. Chem. Soc., A. S. T. M., Amer. Gas Assn. Contribution: Co-author with J. F. Byrne, "An Adiabatic Method of Studying Spontaneous Heating of Coal," *Journal*, November, p. 809.

H. L. Dixon. President and Gen. Mgr., H. L. Dixon Co., Pittsburgh, Pa. Member, AMERICAN CERAMIC SOCIETY, 1919—. Contribution: "What is the Effect of Selenium Decolorizer on Tank Blocks?" *Bulletin*, September, p. 332.

W. E. Dornbach.[1] Born, McGregor, Iowa, 1889. B.S., Ceramic Engineering, Iowa State College, 1911. Worked with Amer. Brick and Tile Co., Mason City, Ia. Morey Clay Products Co., Ottumwa, Ia. Southern Clay Mfg. Co., Warrior, Ala. Warrior and Robbins (Tenn. Plants). Auburn Shale Brick Co., Auburn, Pa. Amer. Refrac. Co., Magnesite and Chrome Brick Plant, Baltimore, Md. General Refractories Co. (main office), Philadelphia, Pa. to date. District Chief, Indus. Fur. Sec., U. S. Fuel Administration during World War. Member, AMERICAN CERAMIC SOCIETY, 1911—. Offices: Chairman, Membership Comm., Refractories Division, 1922. Refractories Div., representative on Comm. C-8, A. S. T. M., 1923. Comm., Sections and Divisions. Comm. on Publications (*Journal*).

Conrad Dressler. *Bull.*, **3** [1], 18. Office: Comm. on Data.

E. V. Eskesen. *Bull.*, **2** [7], 235. Contribution: "The Investigation of Terra Cotta Work at the Bureau of Standards," *Bulletin*, May, p. 158.

George P. Fackt. *Bull.*, **3** [1], 18. Office. Councillor, Terra Cotta Division.

R. F. Ferguson. *Bull.*, **3** [1], 19. Office: Secretary, Refractories Division. Editor, Clay Refractories Bibliography.

A. N. Finn. *Bull.*, **3** [4], 132. Offices: Secretary, Glass Division. Chairman, Comm. on Standards (Tests). Comm. on Papers and Program.

F. C. Flint. *Bull.*, **3** [1], 19. Office: Councillor, Glass Division. Contribution: Co-author with M. C. Booze, "Checker Brick for Resisting Alkaline Slags," *Journal*, August, p. 594. Abstractor.

H. D. Foster. *Bull.*, **3** [1], 20. Contribution: "Strength, Absorption and Freezing Resistance of Hollow Building Tile," *Journal*, March, p. 189. Abstractor.

Sidney L. Galpin. Born, Jefferson, Ohio, 1886. A.B., Western Reserve Univ., 1907. A.M., 1910. Ph.D., Cornell Univ., 1912. Two years geological work on feldspar, etc. Consulting work on clay, petroleum and coal properties. Teaching of geology for fifteen years. Associate Prof. Geology, Iowa State College, Ames, Iowa. Member, AMERICAN CERAMIC SOCIETY, 1911—. Office: Chairman, Comm. on Geological Surveys.

W. D. Gates. *Jour.*, **6** [1], 26. Office: Chairman, Terra Cotta Division. Comm. on Divisions and Sections.

S. L. GALPIN

[1] See page 29 for photograph.

J. W. Gayner. Born, Caven's Point, N. J. General Manager, Lynchburg Glass Corporation, Lynchburgh, Va. Member, AMERICAN CERAMIC SOCIETY, 1922—. Contribution: "How to Get Rid of Scum on a Tank Melting Flint Bottle Glass," *Journal*, March, p. 200.

C. F. Geiger. *Bull.*, 3 [1], 21. Office: Comm. on Standards (Products). Comm. on Papers and Program, Refractories Division.

S. Geijsbeek. *Jour.*, 6 [1], 26. Office: Councillor and Treasurer, Pacific-Northwest Sec.

R. F. Geller. *Bull.*, 3 [1], 21. Office: Chairman, Comm. on Standards. Comm. on Papers and Program, Refractories Division. Contribution: "The Laboratory Testing of Aluminous Refractories," *Journal*, September, p. 663.

Albert C. Gerber. Born, Toledo, Ohio, January, 1893. B.S., Ceramic Eng., Ohio State Univ., 1915. Ceramic Engr., Green Eng. Co., East Chicago, Ind. Staff of H. Koppers Co., Pittsburgh, Pa., 1916. U. S. Army during World War. Ceramic Eng., Trenton Fire Clay and Porcelain Co. Ceramic Eng., Electric Porcelain and Mfg. Co., Trenton, N. J. to date. Member, AMERICAN CERAMIC SOCIETY, 1923—. Contribution: "The Use of Gelatine in Glaze Application," *Journal*, June, p. 494.

ALBERT C. GERBER

Leon E. Geyer. Chief Clerk, U. S. Bur. Mines, Ceramic Expt. Station, Columbus, Ohio. Advertising Manager, *Journal*.

L. E. GEYER

H. W. Gillette. Born, N. Y. State, December, 1883. A.B. and Ph.D., Cornell Univ. Chemist with Thomas A. Edison, A. D. Little, Inc., Aluminum Castings Co., U. S. Bur. Mines (12 years). Chief Director of Metallurgy, Bur. Standards, Washington, D. C. to date. Contribution: Coauthor with E. L. Mack, "The Electric Brass Furnace Situation," *Journal*, April, p. 288.

James Gillinder. Born, Philadelphia, Pa., 1880. B.S., Chemistry, Univ. of Penna. Instructor, Univ. of Pa., 1900–02. Manager, Gillinder & Sons, Inc., Philadelphia. Supt. Gillinder Brothers, Inc., Port Jervis, N. Y., 1912 to date. Member, AMERICAN CERAMIC SOCIETY, 1918—. Office: Comm. on Research, Glass Division.

JAMES GILLINDER

A. F. Gorton. *Jour.* 6 [1], 69. Abstractor.

A. F. Greaves-Walker. *Jour.*, 6 [1], 44; *Bull.*, 3 [9], 356. Office: Trustee. Associate Editor, *Journal*.

M. E. Gregory. Born, Caton, N. Y., July, 1864. Graduate, Corning Free Academy, 1886. Taught school, N. J. (4 years). Entered terra cotta business, 1890. Bought business, 1896. Mfg. paving brick, face brick, and architectural terra cotta until Jan. 1, 1924. Manuf. only architectural terra cotta to date. Company name, "Corning Terra Cotta Company." Member, AMERICAN CERAMIC SOCIETY, 1917—. Ex-

M. E. GREGORY

Pres., M. B. M. A. and N. Y. State Builders' Assn. Office: Councillor, Terra Cotta Division.

J. W. Greig. Born, Wingham, Ontario, 1895. B.S., Queen's Univ. Petrologist, Geophysical Laboratory. Co-author with N. L. Bowen, "The System Al_2O_3–SiO_2," *Journal*, April, p. 238.

R. E. Griffith. Manager, Refractories Sales, E. J. Lavino & Co., Philadelphia, Pa. Member, AMERICAN CERAMIC SOCIETY, 1920—. Contribution: "Chrome Refractories for the Open Hearth," *Journal*, September, p. 690.

J. W. GREIG

F. F. Grout. Born, Rockford, Ill., January, 1880. B.S., Univ. of Minn., 1904. Ph.D., Yale, 1916. Teaching and geol. surveys, 1904–1924. Prof. of Geol. and Mineralogy, Univ. of Minn. Contribution: "The Relation of Texture and Composition of Clays," *Journal*, February, p. 122.

F. F. GROUT

Julius Grunwald.[1] *Bull.*, **3** [6], 235. Contribution: "European Practice in the Manufacture of Enameled Cast Iron Ware," *Journal*, February, p. 118.

V. K. Haldeman. Born Morrill, Kans., March, 1899. B. S., Univ. of Ill., 1924. Ceramic Engineer, Beaver Falls Art Tile Co., Beaver Falls, Pa. Member, AMERICAN CERAMIC SOCIETY, 1924—. Contribution: "Aventurine Glazes," *Journal*, October, p. 824.

Abel Hansen. Born, Copenhagen, Denmark, August, 1863. Copenhagen High School, 1879. Danish Army, 3 years. Learned manufacture and baking of clay, Esberg, Denmark, 9 years. Located at Perth Amboy, N. J. Perth Amboy Terra Cotta Co. (2 years). Standard Terra Cotta Works (16 years). Established Fords Porcelain Works, sole owner, 1906. President, New Jersey Clayworkers Assn. Member: AMERICAN CERAMIC SOCIETY, 1908—. Office: Chairman, Standing Comm. on Membership.

J. E. Hansen. Born, Fowler, Ind., 1898. B.S., Univ. of Ill., 1920. Chemist, Enameling Plant of Benjamin Electric Co., Des Plaines, Ill., 1918. Since 1920 to date, Industrial Fellow, Mellon Institute, research and plant development work on vitreous enamels for the Stove Founder's Research Association. Member AMERICAN CERAMIC SOCIETY, 1920—. Office: Comm. on Data, Enamel Division. Comm. on Membership. Contribution: "Discussion on Charles

ABEL HANSEN

[1] Deceased.

Musiol's paper, "Exact Notions of Fluorine Enamels," *Journal*, February, p. 115.

Harold C. Harrison. Born, Columbus, Ohio, November, 1899. B.S. Metallurgical Engineering, Ohio State Univ., 1922. B.S. Mechanical Eng., Ohio State Univ., 1923. U. S. Bureau of Mines, Ceramic Expt. Station, Columbus, Ohio, on coöperative work with McLanahan and Watkins Co. Member, AMERICAN CERAMIC SOCIETY, 1923—. Contribution: "Roof Brick for the Open Hearth," *Journal*, September, p. 698.

J. E. HANSEN

HAROLD C. HARRISON

William N. Harrison. Born, Tunstall, Va. B.S., Chemistry, Virginia Polytechnic Inst. in 1920. M.S., Univ. of Chicago, 1921. Enameled Metals Section, U. S. Bur. Standards, Washington, D. C., 1922 to date. Member, AMERICAN CERAMIC SOCIETY, 1923—. Office: Comm. on Standards (Tests), Enamel Division. Contributions: Co-author with R. R. Danielson and T. D. Hartshorn, "Factors Affecting the Warpage of Sheet Iron and Steel in Enameling," *Journal*, May., p. 326. Co-author with H. G. Wolfram, "The Development of Jewelry Enamels," *Journal*, December, p. 857.

W. N. HARRISON

T. D. Hartshorn. *Bull.*, **3** [1], 23. Contribution: Co-author with R. R. Danielson and W. N. Harrison, "Factors Affecting the Warpage of Sheet Iron and Steel in Enameling," *Journal*, May, p. 326.

F. A. Harvey. *Jour.*, **6** [1], 55. Office: Chairman, Refractories Division. Comm. on Divisions and Sections. Contributions: "Notes on Secondary Expansion of Flint Clay," *Journal*, June, p. 455. Co-author with E. N. McGee, "Factors Affecting the Resistance of Silica Refractories to Abrasion," *Journal*, December, p. 895.

George H. Hays. Assistant Mgr., Vitreous Enameling Co., Cleveland, Ohio. Member, AMERICAN CERAMIC SOCIETY, 1920—. Office: Secretary, Northern Ohio Section.

Perry D. Helser. *Bull.*, **3** [1], 24. Abstractor.

H. B. Henderson. *Bull.*, **3** [3], 99. Office: Treasurer.

A. V. Henry. *Bull.*, **3** [1], 45. Office: Comm. on Standards (Products), Heavy Clay Products Division. Contribution: "The Electrical Resistivity of Refractories," *Journal*, October, p. 764.

J. W. Hepplewhite. *Jour.*, **6** [1], 60. Office: Comm. on Membership, Refractories Division.

H. W. Hess. *Bull.*, **3** [1], 25. Office: Representative, Comm. on Nominations, Glass Division.

E. L. HETTINGER

E. L. Hettinger. Born, near Reading, Pa., 1879. Interstate Commercial College and Alexander Hamilton Institute. Penn

sylvania Optical Co., 1898. Assistant Secy. and Purchasing Agent, Willson Goggles, Inc., Reading, Pa., to date. Contribution: "The Development of Transparent Colored Glass in America for Goggle Purposes," *Journal*, May, p. 318.

L. C. Hewitt. *Bull.*, **3** [1], 25. Offices: Chairman, Comm. on Papers and Program, Refractories Division. Secretary, St. Louis Section.

C. W. Hill. *Bull.*, **3** [1], 25. Offices: Rep. Comm. on Nominations. Comm. on Standards (Tests and Products), Terra Cotta Division.

E. C. Hill. *Bull.*, **3** [1], 25. Offices: Comm. on Research, Terra Cotta Division. Comm. on Standards (Raw Materials).

Roy Horning. *Bull.*, **3** [1], 26. Office: Associate Editor, *Journal.*

J. C. Hostetter. *Jour.*, **6** [1], 54. Offices: Trustee, Glass Division. Comm. on Data.

A. F. Hottinger. *Jour.*, **5** [9], 204; *Jour.*, **6** [1], 46. Office: Comm. on Education, Terra Cotta Division.

F. T. Houlahan. President, Builders Brick Co. Member, American Ceramic Society, 1924. Secretary, Pacific Northwest Section.

H. E. Howe

Harrison Estell Howe. Born, Georgetown, Ky., December, 1881. B.S., Earlham College, 1901. Graduate Work, Univ. of Mich., 1901–02. M.S., Univ. of Rochester, 1913. Chemist, Sanilac Sugar Refining Co., 1902–04. Bausch & Lomb Optical Co., various capacities including chief chemist, 1904–15. Arthur D. Little, Ltd., 1916–19. Consulting Chemist, Nitrate Division, Army Ordnance, 1918. Chairman, Division of Research Extension, National Research Council, 1919 to Dec., 1921. Editor, *Industrial and Engineering Chemistry*, 1921 to date. Member, Amer. Chem. Soc., Amer. Electrochem. Soc., A. I. C. E., Soc. of Chem. Industry, Amer. Oil Chemists' Soc., A. A. A. S., Amer. Eng. Council. Contribution: "Scientific Research as an Association Activity," *Bulletin*, June, p. 209.

Raymond M. Howe.[1] *Jour.*, **6** [1], 45, *Bull.*, **3** [5], 169. Office: Vice-president.

Addis E. Hull, Jr. Assistant to General Mgr., A. E. Pottery Co., Crooksville, Ohio. Member, American Ceramic Society, 1923—. Contribution: "One Fire Whiteware through Direct Fired Car Tunnel Kiln," *Journal*, April, p., 285.

Herbert Insley, Jr. *Bull.*, **3** [1], 26. Offices: Comm. on Papers and Program, Glass Division. Secretary, Baltimore-Washington Section. Contribution: "The Microscopic Identification of Stones in Glass," *Journal*, January, p. 14. "Notes on the Behavior of Glass Melting Furnaces," *Journal*, August, p. 583.

Frederick G. Jackson. Born, Beverly, Mass., August, 1881. A.B., Harvard College, 1903. S.M., Harvard Grad. School. Germany, studied under Prof. Haber, one year. Alfred Univ., summer, 1924. University teaching, 3 years. National Carbon Co., Illinois Steel Co., Commercial Chemical Co. Lieut. Naval Reserve, Chemist Submarine Base, New London, Conn. Chemist, U. S. Bur. Mines, Ceramic Expt. Station, 1921 to date. Member, American Ceramic Society, 1922—. Office: Chairman, Comm. on Research, Heavy Clay Products Division. Contribu-

Frederick Gray Jackson

[1] Deceased.

tions: "The Oxidation of Ceramic Wares during Firing. II. The Decomposition of Various Compounds of Iron with Sulphur under Simulated Kiln Conditions," *Journal*, April, p. 223, May, p. 382. III. "The Behavior of Calcium Compounds in Clays," June, p. 427. IV. "The Absorption of Sulphur Gases by Ferric Oxide in Clay," July, p. 532. V. "A Quantitative Study of the Nature of Sulphur Evolution in Kiln Firing," August, p. 634, September, p. 656. Co-author with G. A. Bole, I. "Some Reactions of a Well Known Fire Clay," March, p. 163.

J. T. JANS

John T. Jans. Born, Lemars, Iowa, October, 1890. B.E., Univ. of Iowa, Applied Science, 1912. C.E., Civil, Mech. Engineering and Combustion Engineering, 1919. Design and field work on construction, 1917. Captain, U. S. Army Engineers, France, 1917–19. Holcroft and Co., design, construction and service furnace and kiln work, 1919 to date. Contribution: "Operation Data on Continuous Kiln at Mt. Clemens Pottery Co.," *Journal*, August, p. 626.

ROBT W. JONES

J. A. Jeffery. President, Champion Porcelain Co., Detroit, Mich. Member, AMERICAN CERAMIC SOCIETY. Contribution: "Coördinating Research and Technical Information with Plant Control," *Bulletin*, May, p. 141.

Robert W. Jones. Born, Catskill, N. Y., April, 1882. Educated as mining engineer with special work in geology. Assistant Economic Geologist, N. Y. State Museum, 1912–20. Non-professional work, mining engineer, gold, silver and copper mines, western U. S., Central and South America, 1905–12. Member, AMERICAN CERAMIC SOCIETY, 1916 to date. Office: Comm. on Geological Surveys.

W. R. Kerr. Mellon Institute, Pittsburgh, Pa. Abstractor.

Pierce W. Ketchum. Ceramics Department, Univ. of Illinois, Urbana, Ill. Abstractor.

Herbert S. Kirk. *Jour.*, **6** [1], 52. Office: Secretary, Art Division. Representative, Comm. on Nominations.

A. A. Klein. *Bull.*, **3** [1], 27. Office: Chairman, Comm. on Education, Refractories Division. Comm. on Research. Councillor, New England Section.

T. A. Klinefelter. *Jour.*, **6** [1], 59. Contribution: "Clay Preparation," *Journal*, July, p. 509.

Seiji Kondo. Tokyo Higher Technical School, Asakusa, Tokyo, Japan. Member AMERICAN CERAMIC SOCIETY, 1916—. Abstractor.

H. M. KRANER

Hobart M. Kraner. Born, Columbus, Ohio, November, 1896. B.S., Ceramic Eng., Ohio State Univ., 1921. M.S., Ohio State Univ., 1922. U. S. Bur. Mines, Ceramic Expt. Sta., Columbus Ohio, 1918–19, 1922–23. A. C. Spark Plug Co., April 1923–Nov.

J. S. LATHROP

1924. Illinois Electric Porcelain Co., Macomb, Ill., to date. Member, AMERICAN CERAMIC SOCIETY, 1919—. Contributions: "Sillimanite Development in Some Typical Clays," *Journal*, October, p. 726. "Colors in a Zinc Silicate Glaze," *Journal*, December, p. 868.

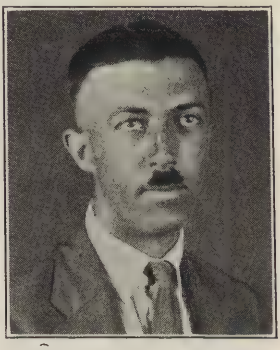
W. H. Landers. St. Louis Lithopone Co., Collinsville, Ill. Member, AMERICAN CERAMIC SOCIETY, 1922—. Contribution: "Feldspar Milling," *Bulletin*, August, p. 300.

R. D. Landrum. *Jour.*, **6** [1], 47. Office: President. Councillor, Northern Ohio Section.

Karl Langenbeck. *Jour.*, **6** [1], 27. Contribution: "What Has Been the Experience in Substituting Domestic Secondary and Primary Kaolins for English China Clays," *Bulletin*, November, p. 417.

John S. Lathrop. Born, Chicago, Ill., 1897. B.S. degree, Univ. of Ill., Ceramic Engineering, 1922. Tropico Potteries Co., Glendale, Calif., 1922 to date. Member, AMERICAN CERAMIC SOCIETY, 1922—. Contribution: Co-author with C. W. Parmelee, "Aventurine Glazes," *Journal*, July, p. 567.

C. H. Lawson. *Bull.*, **3** [1], 28. Office: Secretary, New England Section.



R. D. LEITCH

R. D. Leitch. Born, Terre Haute, Ind., April, 1894, B.S. in Chem. Eng., Rose Polytechnic Inst., 1916. Ch. E., 1921. M.S., 1922. Research Chemist, U. S. Rubber Co., Naugatuck, Conn., 1916–17. Chief chemist, same Company, Mishawaka, Ind., 1917. Research chemist, E. I. du Pont de Nemours and Co., 1917–18, Arlington, N. J. 2nd Lieut. U. S. Engineers, 1918–19. Junior Explosives, Chem., U. S. Bur. of Mines, 1919–20. Vice-pres., The Cellulo Co., Inc., Sandusky, Ohio, 1920–21. Junior Gas Engr., Ill. State Geol. Survey and U. S. Bureau of Mines, Urbana, Ill., 1921–22. Asst. Fuel Engr., U. S. Bur. Mines, 1922–23, Oct. 1, 1924 (investigation of stream pollution and possible methods of control). Member, AMERICAN CERAMIC SOCIETY, 1924—. Amer. Inst. Chemists. Abstractor

W. N. LOGAN

J. T. Littleton, Jr. *Bull.*, **3** [1], 29. Office: Abstractor.

William Newton Logan. Born, Barboursville, Ky., 1869. A.B. and A.M., Univ. of Kans., Ph.D., Univ. of Chicago. Prof. Geol. and Mineralogy, St. Lawrence Univ. Dean, School of Sci. and Prof. of Geol., and Mining Eng., Mississippi Agricultural and Mechanical College. Prof., Econ. Geol., Indiana Univ., State Geologist to date. Member, A. A. A. S., Fellow, Geol. Soc. of Amer., Fellow, Royal Soc. Arts, Fellow, Indiana Acad. Sci. and Kans. Acad. Sci. Contribution: "Refractory Clays of Indiana," *Journal*, March, p. 201.

R. F. Lunger. Contribution: Co-author with R. A. Sherman and W. E. Rice, "The Significance of Drafts in Down-draft, Coal-fired Kilns," *Journal*, April, p. 255.

D. A. Lyon. *Jour.*, **6** [1], 153. Contribution: "Some Considerations of Selections of Refractories for the Open Hearth," *Journal*, September, p. 705.

Edward L. Mack. Born Vergennes, Vt., August, 1890. B.S., Union College, 1912. Ph.D., Cornell Univ., 1916. Chemist and Metallurgist, U. S. Bureau of Mines, 1916 to date. Contribution: Co-author with H. W. Gillette, "The Electric Brass Furnace Refractory Situation," *Journal*, April, p. 288.

Charles Maddock, Jr. Thomas Maddock Sons, Trenton, N. J. Member, AMERICAN CERAMIC SOCIETY, 1922—. Office: Representative, Comm. on Nominations, Whitewares Division.

A. Malinovszky. *Bull.*, **3** [1], 29. Office: Comm. on Divisions and Sections. Chairman, California Section.

M. E. Manson. *Bull.*, **3** [1], 29. Office: Abstractor. Councillor, Enamel Division.

John D. Martin. *Bull.*, **3** [1], 30. Office: Vice-chairman, Heavy Clay Products Division. Contribution: "Further Development of an Automatic Kiln Stoker," *Journal*, December, p. 878.

Oscar E. Mathiasen. Elizabeth, N. J. Contribution: "The Effect of Uranium in Various Types of Glazes," *Journal*, July, p. 499.

Wm. R. Mattson. Born, Philadelphia, Pa., 1891. B.S., Civil Engineering, Mass. Inst. Tech., 1913. Construction engineering, highways and industrial buildings, 4 years. Captain, 101st Engineers, France (2 years). Economic Engineer, Babson Statistical Organization, Wellesley Hills, Mass. (5 years to date). Contribution: "Economic Factors that Make Research in Industry Important," *Bulletin*, May, p. 153.

W. R. MATTSON

F. R. McCannell. Milton Pressed Brick Co., Milton, Ont. Corporation representative, AMERICAN CERAMIC SOCIETY. Office: Comm. on Papers and Program, Heavy Clay Products Division.

G. V. McCauley. Physicist, Corning Glass Works, Corning, N. Y. Member, AMERICAN CERAMIC SOCIETY, 1920—. Office: Comm. on Data.

J. Spotts McDowell. *Jour.*, **6** [1], 55. Office: Trustee, Refractories Division. Comm. on Standards (Definitions). Vice-chairman, Pittsburgh Section.

E. N. MCGEE

Earle N. McGee. Born, Potsdam, N. Y., 1891. B.S., St. Lawrence Univ., 1912. Semet-Solvay and Solvay Process Co., 1916–18. In charge of Refractories Laboratory, same Company, Syracuse, N. Y., 1918 to date. Member, AMERICAN CERAMIC SOCIETY, 1921—. A. S. T. M. Office: Chairman, Comm. on Research, Refractories Division. Contribution: Co-author with F. A. Harvey, "Factors Affecting the Resistance of Silica Refractories to Abrasion," *Journal*, December, p. 895.

T. N. McVay. Born, Hawkins, Pa., February, 1891. B.S., Ceramic Eng., Univ. of Illinois, 1914. Refractory and Brick Plants, 1914–22. Instructor in Ceramic

GEORGE E. MERRITT

Eng., Univ. of Ill., 1922 to date. Member, AMERICAN CERAMIC SOCIETY, 1923—. Office: Abstractor.

George E. Merritt. Born, Indianapolis, Ind., June, 1890. B.A., Pomona College, 1913. Graduate work, Univ. of Wis., Columbia Univ. U. S. Bur. Standards, Washington, D. C., work in optical instruments, ceramics and interference, index of refraction, thermal expansion and time change. Contribution: "Thermal Expansion of Fused Quartz," *Journal*, November, p. 803.

Gilbert F. Metz. Born, Omaha, Nebr., October, 1889. B.S., Mine Eng., School of Mines, Univ. of Mo., 1914. Eng. of Mines degree, 1919. Atlas Portland Cement Co., surveyor and draftsman, plant engineer, 1914–18. Engineer, Officer, Transport Duty, U. S. Navy, 1918–19. Division Sales Engineer, Engineer, Hardinge Co., Inc., 1919 to date. Member, AMERICAN CERAMIC SOCIETY, 1921—. A. I. M. M. E. Contribution, "Ceramic Raw Materials, Driers and Drying," *Journal*, July, p. 504.

L. R. Milford. Laboratory manager, The Solvay Process Co., Syracuse, N. Y. Member, AMERICAN CERAMIC SOCIETY, 1921—. Office: Comm. on Standards (Tests), Glass Division.

CHARLES MUSIOL

C. R. Minton. Los Angeles Pressed Brick Co., Los Angeles, Calif. Member, AMERICAN SOCIETY, 1920—. Contribution: "The Direct-Fired Car Tunnel Kiln on Roofing Tile," *Journal*, November, p. 821.

R. H. Minton. *Jour.*, **6** [1], 42. Office: Editor, Question Box, Terra Cotta Division.

C. H. Modes. Supt. of Furnaces, Illinois Glass Co., Alton, Ill. Member, AMERICAN CERAMIC SOCIETY, 1922—. Contribution: "Longer Life of Our Tanks," *Bulletin*, June, p. 222.

R. J. Montgomery. *Bull.*, **3** [1], 30. Office: Comm. on Data, Glass Division. Office: Abstractor.

Charles Musiol. Born, Budejovice, Czechoslovakia, 1873. Degree, Mech. Eng., Brno, 1894. Manager, Enamel work, Kralovo, Pole, 1896. Technical director, enamelworks "Waulkan," Warsaw, Poland, 1896–1909. Engineering office, constructor and consulting engineer of stamping and enamelworks, Brussels, 1909. Has established six new enamelworks in Europe and one in Brazil. Made inventions in stamping, enameling and laboratory furnaces and enamels. (U. S. A. patent of boronless enamels.) Member, AMERICAN CERAMIC SOCIETY, 1918—. Contribution: "Exact Notions of Fluorine Enamels," *Journal*, February, p. 105.

C. L. NORTON

Louis Navias. *Bull.*, **3** [1], 31. Office: Abstractor.

Charles Ladd Norton. Born, Springfield, Mass., December, 1870. B.S., Mass. Inst. Tech., 1893. Teaching Industrial Physics, Mass. Inst. Tech., 1893 to date. Prof., Indus. Physics. Head of dept. of

Physics in charge of laboratories of Industrial Physics. Director, Division of Industrial Coöperation and Research, M. I. T. For a number of years, president, Asbestos Wood Co., Nashua, N. H. and Asbestos Shingle Co., New York. Member, AMERICAN CERAMIC SOCIETY, 1923—. A. S. M. E., A. S. T. M., Amer. Chem. Soc., Amer. Phys. Soc., Soc. for the Promotion of Eng. Education, Fellow, Amer. Acad. Arts and Sci., Contribution: "Massachusetts Institute of Technology Plan for Industrial Coöperation," *Bulletin*, July, p. 247.

Frederick Harwood Norton. Born, Manchester, Mass., October, 1896. B.S., Physics, Mass. Inst. Tech. Specialized in Aeronautics. Formerly chief physicist, National Advisory Comm. for Aeronautics. Babcock and Wilcox Fellow, Division of Industrial Research and Coöperation, Mass. Inst. Tech. Member, AMERICAN CERAMIC SOCIETY, 1923—. Soc. of Automotive Eng., Amer. Physical Soc. Contribution: "A Qualitative Laboratory Slag Test," *Journal*, August, p. 599; "The Design of Kilns and Furnaces from Mold Tests," *Journal*, October, p. 783.

F. H. NORTON

H. H. Norton. Lieut. Comdr., Fuel Oil Section Plant, Navy Yards, Philadelphia, Pa. Co-author with R. L. Porter, "The Method of Selecting Refractories for Marine Purposes of the Navy," *Journal*, July, p. 575.

MRS. O. P. R. OGILVIE

O. P. R. Ogilvie (Mrs.). Born, Ladonia, Texas, March, 1869. Librarian, Mines Branch, Department of Mines, Ottawa, Canada, 1913 to date. Office: Abstractor.

William Abbott Oldfather. Born, Urumiah, Persia, October, 1880. A.B., Hanover College, 1899. Harvard Univ., 1901, A.M., 1902. Ph.D., Munich, 1908. Instructor and Asst. Prof., Northwestern Univ., 1903–06; 1908–09. Assoc. Prof. and Prof. of Classics, 1909 to date. Contributor to Report of Comm. on Definition of the term "Ceramics," *Journal*, July, p. 597, 1920. "The Meaning of 'Keramos' Once More," *Bulletin*, April, p. 114.

F. B. Ortman. *Jour.*, **6** [1], 49. Office: Councillor, California Section. Comm. on Divisions and Sections.

W. Gresham Owen. Born, Johnstown, Pa., January, 1887. High school education, supplemented by six years in three of Johnstown's business and technical schools. Various positions with Cambria Steel and Midvale Steel and Ordnance Companies (15 years). Asst. manager of sales, Haws Refractories Co., Johnstown, Pa. (5 years to date). Devoting time to study of raw and finished products. Member, AMERICAN CERAMIC SOCIETY, 1923—. Office: Chairman, Comm. on Membership, Refractories Division.

W. G. OWEN

F. T. Owens. *Bull.*, **3** [1], 32. Office: Chairman, Heavy Clay Products Division. Comm. on Divisions and Sections.

C. W. Parmelee. *Jour.*, **5** [9], 215; *Jour.*, **6** [1], 40.

Gordon M. Peltz

Office: Comm. on Data. Councillor, Chicago Section. Abstractor. Contribution: Co-author with John S. Lathrop, "Aventurine Glazes," *Journal*, July, p. 567.

A. R. Payne. *Bull.*, **3** [1], 32. Contribution: "Devitrification in a Lime-Flint Glass Tank," *Journal*, April, p. 271.

A. B. Peck. *Bull.*, **3** [1], 33. Office: Comm. on Divisions and Sections. Chairman, Detroit Section.

Gordon M. Peltz. Born, Philadelphia, Pa., October, 1893. M.E. degree, Columbia Univ., 1915. General design experience, the Surface Combustion Co., New York City (2 years). Furnace engineer, Corning Glass Works ($5^1/_2$ years to date). Member, A. S. M. E. Contribution: "A Graphical Chart for Determining Excess Air in the Combustion of Producer Gas," *Journal*, June, p. 437.

Forrest K. Pence. *Jour.*, **6** [1], 43. Office: Chairman, Comm. on Publications. Comm. on Research, Whitewares Division.

Stuart M. Phelps. Mellon Institute, Pittsburgh, Pa. Contribution: "Discussion on the Disintegration of Clay Refractories in Iron Blast Furnaces," *Journal*, September, p. 717.

James Gordon Phillips. Born, Piqua, Ohio, July, 1897. B.S., Ohio State Univ., Jan., 1921. M.S., O. S. U., 1924. U. S. Bureau of Mines, Ceramic Expt. Station, Columbus, Ohio, Jan., 1921–July, 1922. Ceramic chemist, Consolidated Gas Co., New York Coöperative fellowship, U. S. Bur. Mines and Ohio State Univ., 1923–24. Ceramic Chemist, Standard Oil Co., Elizabeth, N. J. Member, American Ceramic Society, 1922—. Office: Abstractor.

J. G. Phillips

Robert L. Porter. Born, Baltimore, Md., September, 1895. U. S. Naval Academy, 1917. Lieut. U. S. Navy. Contribution: Co-author with H. H. Norton, "The Method of Selecting Refractories for Marine Purposes of the Navy," *Journal*, July, p. 575.

Emerson P. Poste. *Jour.*, **6** [1], 53. Office: Councillor. Comm. on Divisions and Sections. Comm. on Standards (Tests and Products), Enamel Division.

E. E. Pressler

Amos. P. Potts. *Bull.*, **3** [1], 33. Office: Secretary, Heavy Clay Products Division.

Wm. H. Powell. Contribution: "Address on Terra Cotta," *Bulletin*, July, p. 255.

Eugene Edward Pressler. Born, Willow City, Texas, August, 1893. Chemical Eng., Univ. of Texas, 1921. Student, Ceramic Engineering, Ohio State Univ., 1921–22. Ceramic asst., U. S. Bur. Mines, Ceramic Expt. Sta., Columbus, Ohio, 1923–24. Junior Ceramic Engineer, Bur. Standards, Washington, D. C. Member, American Ceramic Society, 1923 to date. Contributions: "A Simple Brick Porosimeter," *Journal*, March, p. 154. "Comparative Tests of Porosity and

Specific Gravity on Different Types of Refractory Brick," *Journal*, June, p. 447.

W. S. Primley. Midland Terra Cotta Co., Chicago, Illinois. Member, AMERICAN CERAMIC SOCIETY, 1912—. Office: Comm. on Membership, Terra Cotta Division.

Ross C. Purdy. *Jour.*, **6** [1], 38. Office: General Secretary. Editor, *Journal.*

B. S. Radcliffe. Northwestern Terra Cotta Co., Chicago, Illinois. Member, AMERICAN CERAMIC SOCIETY, 1915—. Office: Secy., Terra Cotta Division. Comm. on Rules. Contribution: "Terra Cotta Body Investigation," *Journal*, November, p. 834.

Robert C. Rahn. Born, Chicago, Ill., June, 1894. B.S., Ceramic Engineering, Univ. of Ill., 1916. Research work in Ceramics, Western Electric Co., Hawthorn, Ill., 7 years. World war, 2 years. Manufacture of art pottery, Chicago, for the past year to date. Member, AMERICAN CERAMIC SOCIETY, 1918—. Office: Secretary and Treasurer, Chicago Section.

R. C. RAHN

L. B. Rainey. Fallston Fire Clay Co., Fallston, Pa. Member, AMERICAN CERAMIC SOCIETY, 1912—. Office: Question Box, Heavy Clay Products Division.

L. V. Reese. General Manager, Erie City Iron Works, Erie, Pa. Member, AMERICAN CERAMIC SOCIETY, 1924—. Office: Comm. on Research, Refractories Division.

Frederick H. Rhead. *Jour.*, **6** [1], 51. Office: Trustee, Art Division. Comm. on Exhibitions. Chairman, Comm. on Research. Comm. on Publications. Associate Editor.

William E. Rice. Bureau of Mines, Rollo, Mo. Member, AMERICAN CERAMIC SOCIETY, 1923—. Office: Abstractor. Contributions: Co-author with R. A. Sherman and R. F. Lunger, "The Significance of Drafts in Down-draft Coal-fired Kilns," *Journal*, April, p. 255. Co-author with R. A. Sherman, "Determination of the Distribution of Heat in Kilns Firing Clay Wares," *Journal*, October, p. 738.

W. D. Richardson. *Jour.*, **6** [1], 32. Office: Comm. on Rules, Heavy Clay Products Division. Contributions: "Brick at less Cost," *Journal*, August, p. 614.

F. H. Riddle. *Jour.*, **6** [1], 43. Offices: Trustee, Whitewares Division. Comm. on Divisions and Sections. Councillor, Detroit Section.

L. E. Riddle, Jr. Sales Manager, Edgar Plastic Kaolin Co., Metuchen, N. J. Member: AMERICAN CERAMIC SOCIETY, 1923—. Office: Comm. on Membership, Heavy Clay Products Division.

F. G. ROBERTS

H. Ries. *Jour.*, **6** [1], 33. Office: Associate Editor. Comm. on Geological Surveys.

Frank G. Roberts. Maryland State Univ.. Aerial mail service. Installation and service on PEMCO porcelain enamels and equipment, Porcelain Enamel & Mfg. Co., 1919–1924. Now assistant to vice-president, same Company. Member, AMERICAN CERAMIC SOCIETY, 1920—. Office: Chairman, Membership Comm., Enamel Division. Vice-chairman, Baltimore-Washington Section.

James T. Robson. Born, Cleveland, February, 1895. B.S., Chemical Engineering, 1919, M.S., Chemical Engineering, 1920, Ph.D., 1923, Ohio State Univ. Instructor and professor, Ceramic Engineering, Ohio State Univ., 1919 to date. Service Engineer and Labora-

tory Director, C. B. Harrop Co., Columbus, Ohio, 1922 to date. Member, AMERICAN CERAMIC SOCIETY, 1922—. Office: Comm. on Data, Refractories Division. Contribution: Gave valuable assistance in the detail work in the editing and compiling of the "Silica Bibliography." "Comparative Crazing and Chipping of Wet and Dry Process Cast Iron Enamels," *Journal*, July, p. 563. Co-author with J. T. Withrow, "The Dead Burning of Dolomite," *Journal*, January, p. 61, February, 141, March, 207, April, p. 300, May, p. 397.

JAMES T. ROBSON

W. F. Rochow. Born, Columbia, Pa., January, 1889. B.S., Pa. State College, Industrial Chemistry. Harbison-Walker Refractories Co., Pittsburgh, Pa. Member, AMERICAN CERAMIC SOCIETY, 1917—. Office: Comm. on Standards, Refractories Division.

DONALD W. ROSS

Donald W. Ross. Born, Crookston, Minn., January, 1885. B.S., Univ. of Washington, Seattle, Wash., 1910. Denny-Renton Clay and Coal Co., Seattle, Wash. General ceramics under A. V. Bleininger, U. S. Bur. Standards, Pittsburgh, Pa. (4 years). Ceramist, Findlay Clay Pot Co., Washington, Pa., 7 years to date. Member, AMERICAN CERAMIC SOCIETY, 1918—. Soc. Glass Technology. English Ceramic Soc. Offices: Comm. on Papers and Programs, Refractories Division. Comm. on Standards (Raw Materials).

G. ROSS

Gustav Ross. Born, Oberhausen, August, 1876. M.E., Univ. of Liege, Belgium. Asst. professor, Univ. of Liege (1 year). Engineer, Rolling mills of Vieille Montagne works. Borbeck, 1 year and chief engineer (12 years). Gen. Mgr., Grillo Zink Smelting Works (8 years). Consulting engineer (2 years). Gen. Mgr., International Ore & Smelting Co., Saltillo, Mexico, 1922 to date. Contribution: "Fuel Oil Burning to Obtain the Highest Temperature Combined with Uniform Heat Distribution," *Bulletin*, April, p. 117.

HERBERT F. ROYAL

H. F. Royal. Was graduate with honors, Harvard College, 1917. General Electric Co., Lynn, Mass., July, 1917–Feb., 1918. Bureau of Standards, Pittsburgh, Pa., and Washington, D. C. in connection with problems concerning optical glass, Portland cement, magnesite cements and terra cotta, 1918–20. Chief testing chemist, N. J. State Highway Comm., Trenton, N. J., June, 1920–Oct., 1920. Champion Porcelain Co., Detroit, Mich., 1920 to date. Member, AMER-

ican Ceramic Society, 1922—. Office: Secretary, Detroit Section.

Thomas H. Sant. Born, Stoke-on-Trent, England, 1877. Was graduated from Orme School. Studied six years in France, Switzerland and Spain. Foreign Dept., Wenger's Ltd. (3 years). Entered into partnership with John Sant, 1904. President of John Sant & Sons Co., on death of John Sant, 1914. Member, American Ceramic Society, 1904—. Office: Treasurer, Pittsburgh Section since 1914.

Thomas H. Sant

Francis A. H. Schepers. Born, Maastricht, Holland, January, 1890. Attended various art schools in Europe. Research and factory control, Victor Chemical Works, Chicago, Ill. (5 years). Ceramist, American Terra Cotta and Ceramic Co., 7 years to date. Member, American Ceramic Society, 1922—. Contribution: "The Pulsichrometer," *Bulletin*, February, p. 53.

Francis A. H. Schepers

Edward Schramm. Chem. Eng., Columbia Univ., 1909. Ph.D., 1913. Assistant chemist, Bureau of Standards, 1913–16. Research chemist, American Zinc, Lead and Smelting Co., 1916–18. Bridgeport Brass Co., 1918–19. Chemist, Onondaga Pottery Co., Syracuse, N. Y., 1919 to date. Member, American Ceramic Society, 1920—. Office: Abstractor. Comm. on Data, White Wares Division. Contributions: "Observations on the Properties of Clays and Clay-Grog Bodies," *Journal*, April, p. 282. "The Determination of Porosity of China by the Water Smoking Methods," *Journal*, June, p. 444.

Edward Schramm

Frederic W. Schroeder. Born, Warrenton, Mo., 1899. A.B. degree, Central Wesleyan College, 1919. Fellowship in ceramics, Univ. of Wash., 1922–23. M.S. degree, Univ. of Wash., 1924. U. S. Bureau of Mines on helium investigation, 1919–22. U. S. Bureau of Mines, on refractory requirements for metallurgical furnaces. Contribution: "High Temperature Load and Fusion Tests of Fire Brick from the Pacific N. W. in Comparison with Other Well-known Fire Brick," *Journal*, January, p. 34. Co-author with Hewitt Wilson and C. E. Sims, "Artificial Sillimanite as a Refractory," November, p. 842, December, p. 907.

F. W. Schroeder

H. G. Schurecht. *Jour.*, **5** [9], 216; *Jour.*, **6** [1],

172. Office: Comm. on Data, Heavy Clay Products Division. Secretary, Pittsburgh Section.[1] Contributions: "Clay Sewer Pipe Manufacture, IV. The Influence of Different Salt Glazing Temperatures upon the Color and Gloss of Glazes Obtained on Clays with Varying Silica, Alumina and Iron Oxide Contents," *Journal*, June, p. 411. "The Influence of Varying Lime Content in Clays upon Some Properties of Salt Glazes Produced at Varying Temperatures," *Journal*, July, p. 539.

DONALD E. SHARP

Donald E. Sharp. Born, Corning, N. Y., 1896. Major study, physics, minor study, mathematics, Univ. of Wis. and Carnegie Inst. Tech. Assist. in Physics Dept., Corning Glass Works, 1914–17, under J. T. Littleton, Jr., chief physicist. Assistant in physics, Univ. of Wis., 1916–18. Ceramic Dept., U. S. Bur. Standards, 1918. Physicist and technical director, Spencer Lens Co., Optical Glass Plant, Hamburg, N. Y., 1918–21. Manager, 1921 to date. Member, AMERICAN CERAMIC SOCIETY, 1918—. Offices: Abstractor. Comm. on Standards (Tests) Glass Division.

J. B. Shaw. *Jour.*, **6** [1], 57; *Bull.*, **3** [2], 68. Office: Comm. on Data, Refractories Division.

Mary G. Sheerer. *Bull.*, **3** [1], 35. Office: Chairman, Art Division. Comm. on Divisions and Sections. Contribution: "The Development of Decorative Processes at Newcomb," *Journal*, August, p. 645.

T. A. SHEGOG

Thomas A. Shegog. Born, Dublin, Ireland. Royal College of Science, Ireland. Awarded Royal Scholarship. Was graduated with honors, specializing in silicate chemistry, 1886. Private research work in chemistry and lecturer on chemistry and physics in city of Dublin, Technical School, 1886–87. Associate, Inst. of Chemistry, Great Britain and Ireland, 1887. Fellow Chemical Society, London, 1887. Asst. chemist, Royal College of Sci., 1887–91. Fellowship, Inorganic chemistry, Inst. of Chemist, Great Britain and Ireland, 1891. County lecturer, chemistry and metallurgy, and director, technical instruction, Monmouthshire, 1891–98. Prof. Chemistry and Physics, Royal Veterinary College, Ireland, 1901–1904. Chemist and technical advisor, Arklow Terra Cotta Brick and Tile Co., 1904–07. Chief chemist, scientific advisor and technical expert, Cliffe Vale Potteries and Enameled Fireclay Works, Staffordshire, England, 1907–13. Studied ceramics Staffordshire Pottery School, 1907–09. Came to U. S., 1913. Chemist and consulting engr., Trenton Potteries Co., 1913–23. During war, research chemist for Butterworth-Judson Corp. and Calco Chemical Co. Ceramic engr., Sebring Pottery Co., and associate potteries, March 1923 to date. Member: Fellow, Amer. Inst. Chemists, AMERICAN CERAMIC SOCIETY, 1922—. Contribution: "Note on an

R. A. SHERMAN

[1] Resigned Sept. 1, upon removal to Washington, D. C.

Unusual Case of Warping of Flat Ware in the Glost Kiln," *Journal*, May, p. 377.

Ralph A. Sherman. Born, Oskaloosa, Iowa, 1896. A.B., Iowa State Univ. U. S. Bur. Mines, Pittsburgh Expt. Station, research on combustion problems and efficiency in use of fuels, 5 years. Survey of boiler furnace refractories to date. Member, AMERICAN CERAMIC SOCIETY, 1924—. Contributions: "Combustion in Kilns Burning Refractory Ware," *Journal*, March, p. 175. Co-author with R. F. Lunger and W. E. Rice, "The Significance of Drafts in Down-draft, Coal-Fired Kilns," *Journal*, April, p. 225. Co-author with W. E. Rice, "Determination of the Distribution of Heat Kilns Firing Clay Wares," *Journal*, October, p. 738.

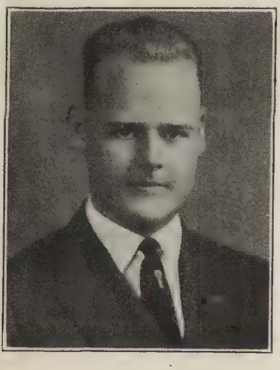
R. R. Shively. Washington, Pa. Member, AMERICAN CERAMIC SOCIETY, 1919—. Office: Chairman, Membership Comm., Glass Division.

A. Silverman. *Jour.*, **6** [1], 61. Office: Comm. on Education, Glass Division. Councillor. Chairman, Comm. on Divisions and Sections. Contributions: Co-author with W. J. Sutton, "The Electrical Conductivity of Sodium Chloride in Molten Glass," *Journal*, February, p. 86. "Colloids in Glass," *Journal*, November, p. 795.

C. E. SIMS

Clarence E. Sims. Born, Chicago, Ill., July, 1893. B.S., Chemical Engr., Univ. of Ill., 1915. M.S., Metallurgy, Univ. of Utah, 1916. Electrolytic zinc with Anaconda Copper Mining Co., $2^1/_2$ years. Caustic soda and bleaching powder, Michigan Electrochemical Co., $^1/_2$ year. Research Division, Chemical Warfare Service, 1 year. Electrometallurgist, Bur. of Mines, Seattle, Wash., 3 years. Contribution: Co-author with Hewitt Wilson and F. W. Schroeder, "Artificial Sillimanite as a Refractory," *Journal*, November, p. 842, December, p. 907.

George Sladek. Born, Chicago, Ill., March, 1896. B.S., 1917, M.S., 1920, Univ. of Ill. Ceramic engineer, Beaver Falls Art Tile Co., Beaver Falls, Pa., June, 1920 to date. Member, AMERICAN CERAMIC SOCIETY, 1919—. Office: Comm. on Standards (Tests and Products), White Wares Division.



C. A. SMITH

Charles A. Smith. Born, Corning, Ohio, October, 1901. B.Cer.E., Ohio State Univ., 1923. Special student, Metallurgy, Lehigh Univ., 1923–24. Member, AMERICAN CERAMIC SOCIETY, 1921—. Honorary Societies, O. S. U. Plant experience during summers. Contribution: "The Manufacture of an Insulating Brick from Diatomaceous Earth," *Journal*, January, p. 52.

C. D. Smith. Simplex Engineering Co., Washington, Pa. Contribution: "Some Combustion Problems in Glass Making," *Journal*, August, p. 603.

H. H. Sortwell. *Bull.*, **3** [1], 36. Contribution: "The Bonding Effect of Ball Clays in Fired Bodies," *Journal*, February, p. 75.

Ira E. Sproat. *Bull.*, **3** [1], 36. Office: Comm. on Membership, White Wares Division.

H. F. Staley. *Jour.*, **6** [1], 42. Office: Abstractor. Comm. on Research, Enamel Division. Contribution: "Suggestions for Development in Enameling Technology," *Journal*, October, p. 719.

August Staudt. *Bull.*, **3** [6], 234. Office: Vice-president.[1] Comm. on Rules, White Wares Division.

W. J. Stephani. *Bull.*, **3** [1], 57. Office: Councillor, Terra Cotta Division.

H. H. Stephenson. Born, Bellary, India (Military Station), 1880. Munition chemist during war making explosives for English Navy. Research chemist for American Encaustic Tiling Co., Zanesville, Ohio. Member, AMERICAN CERAMIC SOCIETY, 1923—. Office: Abstractor.

D. F. Stevens. *Bull.*, **3** [1], 37. Office: Comm. on Papers and Program, Heavy Clay Products Division. Representative, Comm. on Nominations.

H. R. STRAIGHT

Halver R. Straight. Born, El Paso, Ill., August, 1884. Mechanical Engineering, Univ. of Ill., 1907. General manager, Adel Clay Products Co., 1907 to date. President, 1922 to date. Member, Chairman, Standards Committee, Hollow Tile Assn. Contribution: "Planer Economies," *Journal*, July, p. 523.

J. L. STUCKEY

Jasper L. Stuckey. Born, Princeton, N. Car., July, 1891. A.B., Univ. of N. Car., 1918. M.A. degree, 1920. Cornell Univ., 1921–24. Ph.D., Cornell Univ., 1924. Assistant in Geology, Univ. of N. Car., 1919–20. Instructor, 1921. Assistant in Geology, Cornell Univ., 1922–24. Assistant geologist, N. Car. Geol. and Econ. Surv., June, 1920 to Sept., 1921 and summers of 1922 and 1923. Geologist, N. Car. Geological and Economic Surv., July, 1924 to date. Contribution: "The Dehydration Temperature of Pyrophyllite and Sericite," *Journal*, October, p. 735.

R. T. Stull. *Jour.*, **6** [1], 42. Office: Comm. on Research, Refractories Division. Contributions: Co-author with G. A. Bole, "Utilization of Georgia Kaolins in the Manufacture of Face Brick," *Journal*, May, p. 347. "Distribution of Kaolin and Bauxite of the Coastal Plain of Georgia," *Journal*, July, p. 513.

J. D. SULLIVAN

J. D. Sullivan. Born, Columbia Falls, Mont., February, 1900. B.S. and M.S., Chemistry, Univ. of Wash. Teaching fellow in chemistry at Univ. of Washington, 1 year. Analytical and research work with U. S. Bureau of Mines. Junior Physical Chemist, U. S. Bur. of Mines, Berkeley Station, to date. Contribution: Co-author with G. S. Tilley, "Note on the Rational Analysis of Clays," *Journal*, May, p. 379.

Willard J. Sutton Born, Hornell, N. Y., July, 1895. B. S., Ceram., Alfred Univ., 1917. Ph.D. Univ. of Pittsburgh, 1924. U. S. Army 1917–19. At present teacher of Chemistry, Fukien Christian Univ., Foochow, China. Member AMERICAN CERAMIC SOCIETY 1921—.

[1] Elected to fill vacancy caused by death of R. M. Howe.

American Chemical Society. Contribution: Co-author with A. Silverman, "The Electrical Conductivity of Sodium Chloride in Molten Glass," *Journal*, February, p. 86.

B. T. Sweely. *Jour.*, **6** [1], 45. Offices: Chairman, Baltimore-Washington Section. Comm. on Sections and Divisions.

C. F. Tefft. *Jour.*, **6** [1], 55. Office: Trustee, Heavy Clay Products Division.

D. M. Thorpe. General Refractories Co., Buffalo, N. Y. Member, American Ceramic Society, 1922—. Office: Comm. on Membership, Refractories Division.

George S. Tilley. Born, St. George, Maine, November, 1881. A.B. and M.S., Harvard. Research, Carnegie Inst., General Electric Co., U. S. Bur. Stand. and U. S. Bur. Mines. Chemical Engr., Smith-Emery Co., San Francisco and I. F. Laucks, Seattle and Kobe, Japan. Associate Physical Chemist, U. S. Bur. Mines, Berkeley Station, research on methods for manufacture of alumina from clays and other aluminous materials of the U. S., to date. Contribution: Co-author with J. D. Sullivan, "Note on the Rational Analysis of Clays," *Journal*, May, p. 379.

L. J. Trostel

E. W. Tillotson. *Jour.*, **5** [8], 121; *Jour.*, **6** [1], 46. Offices: Associate Editor, *Journal*. Comm. on Research, Glass Division.

C. C. Treischel. *Jour.*, **6** [1], 56. Office: Secretary, White Wares Division. Comm. on Papers and Program. Comm. on Data.

Louis J. Trostel. Born, Galion, Ohio, December, 1893. B.Ch.E., Ohio State Univ., Chemist, Buckeye Steel Castings Co. Referee Chemist, British Ministry of Munitions. Chemical Engr., Standard Chemical Co., Research Engr., U. S. Bur. Mines. Research Engr., U. S. Bur. Chemistry. Chief Chemist, American Refractories Co. Chief Chemist, General Refractories Co., to date. Member, American Ceramic Society, 1923—. Office: Chairman, Comm. on Data, Refractories Division. Contribution: "Note on a Comparative Test of Quicklimes for Silica Brick Manufactures," *Journal*, June, p. 452.

Gus M. Tucker

Gus M. Tucker. Born, Chicago, Ill., May, 1893. Ceramist, Robinson Clay Product Co., Akron, Ohio, 1917–19. Vice-president, Ceramic Products Corporation, Old Bridge, N. J. and Ceramist, N. Y. Architectural Terra Cotta Co., Long Island City, N. Y., 1919 to date. Member, American Ceramic Society, 1917—. Office: Comm. on Coöperation, Terra Cotta, Division.

Karl Turk. *Bull.*, **3** [1], 39. Offices: Councillor, Enamel Division. Councillor, Baltimore-Washington Section.

W. E. S. Turner. Dept. of Glass Technology, The University, Sheffield, England., Contribution, "The Use of Boric Oxide in Glassmaking," *Journal*, May, p. 313.

Robert Twells, Jr. *Bull.*, **3** [1], 39. Contributions: "Handling and Storing Raw Materials to Produce Uniformity in a Body," *Journal*, February, p. 82. "Preparing and Spraying a Glaze Slip with Especial Reference to the Control of Various Operations," *Journal*, June, p. 465.

F. E. TWINING

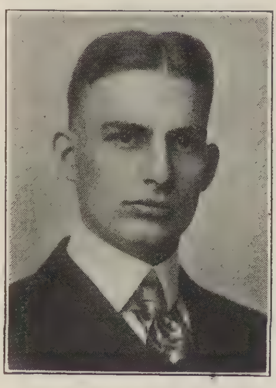
Frederic E. Twining. Born, Croton, Ohio, May, 1874. Chemistry, Denison Univ., Granville, Ohio. General chemical analysis and engineering for 35 years. Special work on chrome and magnesite refractories during the war. Manager Twining Laboratories, Fresno, Calif. to date. Member, AMERICAN CERAMIC SOCIETY, 1919—. Office: Comm. on Papers and Program, Refractories Division.

Joel G. Wahlin. Born, McPherson, Kans., February, 1896. A.B., Bethany College, Lindsborg, Kans., 1917. Univ. of Ill., Grad. School, 1919–20. M.A., Univ. of Kans., 1922. Instructor, Bacteriology, Univ. of Kans., 1922–23. City Bacteriologist, Topeka, Kans. to date. Contribution: "Bacterial Growth in Enamel Slip," *Journal*, March, p. 160.

JOEL G. WAHLIN

F. W. Walker. *Jour.*, **6** [1], 34. Office: Councillor, Pittsburgh Section.

Thomas C. Walker Jr., Born, Wellsville, N. Y., March, 1898. B.S. (Ceramic Engineering), Alfred Univ. N. Y. Architectural Terra Cotta Co. Mosaic Tile Co. Central of Georgia Railway, in coöperation with the U. S. Bur. of Mines. Los Angeles Pressed Brick Co. Member, AMERICAN CERAMIC SOCIETY, 1922—. Contribution: "Waste Heat Driers for Whiteware," *Journal*, August, p. 630.



THOMAS C. WALKER

E. W. Washburn. *Jour.*, **5** [7], 58; *Jour.*, **6** [1], 48. Office: Comm. on Research, Glass Division.

A. S. Watts. *Jour.*, **6** [1], 39. Office: Comm. on Standards, Definitions. Contribution: "Ball Clay Specifications," *Bulletin*, August, p. 288.

R. D. Wells. Factory Manager, The Floyd-Wells Co., Royersford, Pa. Member, AMERICAN CERAMIC SOCIETY, 1919. Office: Comm. on Rules, Enamel Division.

Fred A. Whitaker. Born, Ilkley, England, December, 1885. Haileyburg College, England. General engineering course, Inst. Tech., Charlottenburg, Germany. Ceramic course, Royal School of Ceramics, Bunzlau, Germany under Dr. Pukall. Experience in all phases of stoneware manufacture and erection of chemical plants in Europe. Works manager, chemical stoneware plant, General Ceramics Co., Keasbey, N. J.

F. A. WHITAKER

Member, AMERICAN CERAMIC SOCIETY, 1912—. Office: Abstractor.

Buhel E. Whitesell. Born, Salina, Pa., July, 1893. B.Cer.E., Ohio State Univ., 1922. Member, AMERICAN CERAMIC SOCIETY, 1923—. Ceramic Engineer, Kier Fire Brick Co., 1922 to date. Contribution: "A Dust Collecting System," *Bulletin*, March, p. 77.

B. E. WHITESELL

René V. E. Widemann. Born, Paris, France, October, 1881. Licensed Chemical Engineer. Chemist in the Production of Refractories (sanitary articles) since 1910. Engineer, chief of technical service of the factories of Compagnie Generale de Construction de Tours at Montrouge (Seine), France. Member, AMERICAN CERAMIC SOCIETY, 1922—. Contribution: "The Firing of Refractory Products of France," *Journal*, January, p. 29.

R. V. E. WIDEMANN

W. W. Wilkins. Member, AMERICAN CERAMIC SOCIETY, 1919—. Office: Comm. on Membership, Art Division.

A. E. Williams. *Jour.*, **6** [1], 53. Offices: Comm. on Data. Comm. on Standards (Tests and Products). Councillor, Glass Division.

JAMES R. WITHROW

C. E. Williams. *Bull.*, **3** [1], 42. Contribution: "Operating Conditions in the Open Hearth as They Affect Refractories," *Journal*, September, p. 681.

W. S. Williams. Member, AMERICAN CERAMIC SOCIETY, 1919—. Contribution: "Comparative Service Tests of Gross Almerode and Domestic Clay Pots," *Bulletin*, November, p. 413.

W. E. DORNBACH

James R. Withrow. Born, Philadelphia, Pa., August, 1878. B.S., Univ. of Pa., 1899. Ph.D., 1905. Research plant operation and consulting engineering work in chemical industries, 25 years. Head of Department of Chemical Engineering, Ohio State Univ. Contribution: Co-author with J. T. Robson, "The Dead Burning of Dolomite," *Journal*, January, p. 61, February, p. 141, March, p. 207, April, p. 302, May, p. 397.

Hewitt Wilson. *Jour.*, **6** [1], 111. Offices: Comm. on Geological Surveys. Secretary, Pacific Northwest Section. Contributions:

"High Temperature Load Fusion Tests of Fire Brick from the Pacific Northwest in Comparison with Other Well-Known Fire Brick," *Journal*, January, p. 34. Co-author with C. E. Sims and F. W. Schroeder, "Artificial Sillimanite as a Refractory," *Journal*, November, p. 842, December, p. 907.

Louis A. Wilson. Born, Pawtucket, R. I., July, 1892. B.S. Electro-chemistry, Mass. Inst. Tech., 1914. M.S., 1915. Chief of Testing Dept., N. J. Zinc Co., Palmerton, Pa. Member, AMERICAN CERAMIC SOCIETY, 1923—. Office: Comm. on Membership, Refractories Division.

H. G. Wolfram. *Bull.*, **3** [3], 99. Office: Secretary, Enamel Division. Contribution: "Effect of Zirconia in Enamels for Sheet Steel," *Journal*, January, p. 1.

W. G. Worcester. *Jour.*, **6** [1], 107. Office: Comm. on Geological Surveys.

A. S. Zopfi. *Bull.*, **3** [1], 44. Office: Chairman, Northern Ohio Section. Comm. on Divisions and Sections.

NOTES AND NEWS

MINUTES OF MEETING OF TECHNICAL COMMITTEE ON REFRACTORIES

Federal Specifications Board

Minutes of Meeting held on Thursday, Nov. 20, 1924, at 10 A.M. at the Bureau of Standards.

Members present:

L. H. Kenney, Navy Yard, Philadelphia, Pa.

M. E. Miller, War Dept., Washington, D. C.

H. G. Donald, Lieut.-Commander, United States Navy Fuel Oil Testing Plant, Philadelphia, Pa.

G. B. Vroom, Lieut.-Commander, United States Navy, Washington, D. C.

F. M. McGeary, Navy Dept., Washington, D. C.

E. L. Lasier, U. S. Shipping Board, Emergency Fleet Corporation, New York City.

N. F. Harriman, Vice-Chairman, Federal Specif. Board, Washington, D. C.

R. F. Geller, Bur. of Stand., Washington, D. C.

W. L. Pendergast, Bur. of Stand., Washington, D. C.

The following members were present as an advisory committee from the industry:

Ross C. Purdy, AMERICAN CERAMIC SOCIETY, Columbus, Ohio.

E. B. Powell, A.S.M.E., Boston, Mass.

L. C. Hewitt, Refrac. Mfgrs. Assn., St. Louis, Mo.

M. C. Booze, Refrac. Mfgrs. Assn., Pittsburgh, Pa.

J. S. McDowell, Refrac. Mfgrs. Assn., Pittsburgh, Pa.

The title of the Proposed Master Specification for Fire Clay Refractories was changed to Proposed Master Specification for Fire Clay Brick. Several other revisions of minor importance were made in the Specification and it was then adopted by unanimous vote and recommended to the Federal Specifications Board for approval. Interested parties are to obtain copies of the Master Specification from the Chairman of the Federal Specifications Board, Washington, D. C.

The Proposed Master Specification for Fire Clay was reconsidered and revised, particularly as regarded the screen test and bonding test. It was suggested that the

clays which are to be used with brick of Class SH 75 and H 75 should be tested at a maximum temperature of 1400°C for five hours and that clay used with lower grades of brick should be tested at a maximum temperature of 1350°C for five hours. It was also suggested that the method of applying the mortar and of laying up the joint should be revised so as to permit of forming a better bond.

Data presented regarding a screen test indicate that the present specification may be too rigid. It is expected, however, that the Government will continue to ask for fire clay, of which at least 96% will pass through a 20-mesh screen, until further data have been obtained which will show conclusively whether or not this is practicable. The chairman was requested to prepare the Proposed Master Specification for Fire Clay in revised form and distribute the same to members and advisory members for criticism and comment.

The Committee adjourned at 3:15 P.M.

R. F. GELLER, Vice-Chairman, F. S. B. Subcommittee on Refractories.

BUREAU OF STANDARDS NOTES

Preparation of Standard Specifications for Whiteware Pottery

A Master Specification for Vitrified Chinaware has been finally accepted and became effective on Nov. 5, 1924, as Federal Specifications Board Specification No. 243. This master specification for the purchase of vitrified chinaware has been evolved after an investigation covering a period of several years, in which manufacturers of vitrified chinaware through their Association have coöperated with the various Government departments using this material, and with the Bureau of Standards in which the laboratory work was carried out. The specification covers material known as thick china, hotel or rolled edge china, and medium weight china. The material, workmanship, and general requirements are given, as well as the detailed requirements in which there is defined in numerical values the resistance which this type of ware shall show to impact, chipping, and temperature change in order to be satisfactory. The specification further presents a detailed list of the trade size, actual size, maximum weight, and tolerance in size of every piece of ware which shall be used by the Government in its dining room service, enlisted men's service and hospital service.

When the preparation of this specification was undertaken by the Federal Specifications Board the Bureau of Standards was entrusted with the investigational work.

In the course of this investigation practically every make of vitrified chinaware manufactured in this country was tested, as well as several well known brands of chinaware from England, France, Germany, and Japan. The information obtained is considered as confidential, and the comparative value of the different brands cannot be supplied. It is believed, however, that the specification, a copy of which will be sent to interested parties on application to the Chairman, Federal Specifications Board, Bureau of Standards, Washington, D. C., will furnish sufficient data to be used as a basis for the purchase of vitrified chinaware for general use.

Problems Relating to Saggers

Chinaware to be successfully fired and glazed must be carefully placed in heat-resistant containers, known as saggers. These prevent the flame and soot present in the kiln from harming the ware. Saggers are also used in the tile, abrasive, and other clay industries where firing of the product requires great care. It is desirable to have these saggers made of clay of considerable strength and of good refractory quality.

The Bureau, in coöperation with the United States Potters' Association, is conduct-

ing an investigation which involves a geographical study of sagger clays and their classification according to properties. It has for its ultimate purpose the increase of the life of the sagger, thereby assisting the manufacturers who find the cost of saggers discouragingly high due to unsatisfactory service.

Approximately 10,000 routine tests made on the fifty-five clays included in this investigation have given the following information: The water of plasticity was found to range from 16 to 46% and the drying shrinkage from 10 to 20%. In the unfired state the porosity was found to vary from 24.5 to 50%, and the transverse strength ranged from 50 pounds per square inch to 380 pounds per square inch. The lowest softening point of these clays was equivalent to that of Orton cone 14, from which point they ranged to higher than cone 33. Specimens of each clay were subjected to five progressive firings ranging from 1150°C to 1310°C, with an increase of 40°C between succeeding firings and all of the clays except three were not overfired at the highest temperature. Clays fired to 1150°C showed a porosity ranging from 19.5 to 46.5%, and a volume shrinkage ranging from 1.9 to 16%, while after firing to 1190°C, the porosity varied from 14 to 46% and the volume shrinkage from 2.7 to 18%. After firing to 1230°C the porosity ranged from 8 to 40.8% and the volume shrinkage from 4 to 24.7%, while after the 1270°C firing the porosity varied from 1 to 38.5% and the volume shrinkage from 2.1 to 35.7%. The final firing (1310°C) produced a porosity varying from 8.8 to 39% and a volume shrinkage varying from 2.5 to 18.5%. Incomplete data covering the transverse strength tests indicate the strength to increase with succeeding firings up to 1270°C, while at 1310°C a large number of the clays show a decrease. The lowest fired transverse strength determined was 800 pounds per square inch, while the highest was 5300 pounds per square inch.

Coöperation by manufacturers permitted the repeated firing of a number of clays and mixtures of clays to as many as 26 burns under actual plant conditions. Specimens were returned by the potteries to the Bureau at intervals of three firings and progressive changes in their physical and chemical properties studied. Data collected indicate that repeated firings have very little effect on the properties of these clays.

A preliminary comparison of the results of the microscopic examination and the results of the physical tests have shown that the behavior of the clays depends to a certain extent upon the kinds and relative amounts of the minerals in the raw clays and the relative amounts of quartz, glass, and $3Al_2O_3.SiO_2$ crystals present in the fired body. After all preliminary data are collected, additional work will be done on the groups into which the clays are classified.

Use of Hydrated Lime in Portland Cement Mortar

It is quite common practice to add hydrated lime to Portland cement mortar, to improve its working qualities, while on the other hand Portland cement is added to lime mortar to hasten its set and increase its strength. The quantities of each material vary with the locality and the opinion of the user. Obviously there is a mix best adapted for given conditions. The determination of these mixes has been the subject of many investigations covering a number of years. An investigation has been completed at the Bureau dealing with the measurement of plasticity, time of set, yield, shrinkage, and tensile strength, together with a resumé of the literature upon these subjects. Many interesting points have been brought out, including:

(1) The richer the cement mortars, and the higher the percentages of lime which they contain, the more mixing water is required to bring them to a given consistency.

(2) A cement mortar to which lime has been added requires additional water, but this additional water increases shrinkage possibilities; therefore lime should be limited

in cement mortars where it is desirable to keep the shrinkage low. The principal advantages of the lime are that it increases workability, tends to prevent segregation and may reduce permeability if used in the proper proportion. Lime retards the set of cement mortars.

(3) The substitution of lime for an equal volume of cement always results in a decrease in strength. The substitution of lime for an equal weight of cement can not be expected to increase the strength of a cement mortar which is richer than 1:4.

(4) The desirable properties of cement-gaged lime mortar are short time of set, strength, elasticity, and workability.

A study of the literature indicates that: Inert, powdered admixtures possess positive merit for reducing permeability of mortars to water when applied to mortars that are not too rich; the strongest mortars may not always have the greatest adhesion; extra sand reduces adhesion of mortars; the strength of masonry depends upon the strengths of brick, mortar, and bond between mortar and brick.

Comparison of American and Foreign Clays as Paper Fillers

There are approximately from 200,000 to 300,000 tons of clay used annually in the paper industry of the United States. Because the larger portion of this amount is of foreign source and the clay resources of the United States are to a great extent undeveloped, the following investigation was made by the Bureau of Standards to ascertain the relative merits of American and foreign clays for use as paper fillers.

The term "clay" is applied to a variety of earthy substances, differing widely in their origin and composition and in many of their physical properties. The essential requirements of a paper-making clay are: Good color; low content of grit, mica, and other impurities; and uniformity. The first requirement must be possessed by the clay in its original state, but the percentage of impurities, such as grit and mica, can be lowered by washing and separation.

The paper section of the Bureau of Standards is equipped for making paper in a semi-commercial way and under practical mill conditions. The experimental paper-making equipment available for the work on clays consisted of a 50-lb. wood tub beater with manganese-bronze bars and plate, a small Jordan with iron bars, a 4-plate screen, and a 29-in. Fourdrinier machine with wire 33 ft. long and having two presses, nine 15-inch driers, a small machine stack of seven rolls, and a reel.

Commercial soda and sulphite pulps, and 8 representative clays, 5 American and 3 foreign, were used in this investigation. Preliminary runs established the best method of handling clay and determined constant factors.

The comparative study included tests for the amount of clay retained in the paper, the quality of the paper produced, and those physical properties of the clay (grit, etc.) that might affect the paper-manufacturing processes. Measurements for clay retention included analyses of samples taken at 13 different positions on the paper machine. The retention values obtained for the 8 clays (Nos. 1 to 5, domestic; Nos. 6 to 8, foreign) were: using 20% clay, 0.620, 0.611, 0.636, 0.630, 0.633, 0.655, 0.642, and 0.655, respectively; using 30% (runs varying per cent being made for only two clays), clay No. 3, 0.600, clay No. 6, 0.632; using 10%, clay No. 3, 0.720, clay No. 6, 0.748; and, using 5%, clay No. 3, 0.744, clay No. 6, 0.740.

Similar tests were also made on samples taken from the paper machine of a commercial mill in operation. The retention data agree with the results obtained in duplicate work in the experimental mill of the bureau. The commercial-mill test also included a study of white-water losses. Determinations made during the seven and one-quarter-hour test period show that, on a 24-hour basis, without a save-all there would have been

a loss of 3310 lbs. of clay and 2369 lbs. of pulp. By using the save-all there would be a loss of only 168 pounds of clay and 31 lbs. of pulp during that interval. The save-all not only increased stock recovery, by permitting the reuse of water with high concentration of stock for dilution purposes, but also effected a saving of thousands of gallons of water during the 24 hours.

Measurements made on physical properties of the clays failed to show any correlation between such properties and the amount of retention in paper, but the color and grit test slightly favored the foreign clays, although not sufficiently to justify the consideration of only these properties in the selection of clays. Physical tests made on the finished paper (bursting strength, finish, etc.) showed the results to be independent of the kind of clay added. Further details concerning this work will be found in Tech. Paper, No. 262 of the Bureau of Standards which may be obtained from the Superintendent of Documents at 15 cents a copy.

CALENDAR OF CONVENTIONS

Organization	Date	Place
AMERICAN CERAMIC SOCIETY (Annual Meeting)	Feb. 16–21, 1925	Columbus, Ohio
Am. Assn. of Flint and Lime Glass Mfrs. (Annual Meeting)	July, 1925	Atlantic City, N. J.
Am. Soc. for Testing Materials	June 22–26	Atlantic City, N. J.
Am. Concrete Institute	Feb. 24–27, 1925	Chicago, Ill.
Common Brick Mfrs. Assn.	Feb. 9–13, 1925	Chicago, Ill.
Hollow Bldg. Tile Assn.	Jan., 1925	Chicago, Ill.
Manufacturing Chemists' Assn.	June, 1925	New York City
Mining & Met. Society of America	Jan. 13, 1925	New York City
Natl. Assn. of Mfrs.	May, 1925	New York City
Natl. Assn. of Mfrs. of Pressed and Blown Glassware	March, 1925	Pittsburgh, Pa.
Natl. Assn. of Stove Mfrs.	May 13–14, 1925	New York City
Natl. Brick Mfrs. Assn.	Jan. 26–31	Washington, D. C.
Natl. Clay Products Industries Assn.	April, 1925	Chicago, Ill.
Natl. Lime Association.	May, 1925 (?)	
Tenth Exposition of Chem. Industries	Sept. 28–Oct. 3, 1925	New York City
Tile & Mantel Contractors' Assn. of America	Feb. 9, 1925	Louisville, Ky.
Western Paving Brick Mfrs. Assn.	Jan., 1925	Kansas City, Mo.

BULLETIN

of the

American Ceramic Society

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific and Art Questions and Promotion of Coöperative Research

Vol. 4 — February, 1925 — No. 2

THE THIRTIETH ANNIVERSARY OF CERAMIC EDUCATION

The beginnings of ceramic education were made thirty years ago. These took energetic organizing, securing of influential backing and a demonstration of the prospective industrial value. It was in Ohio that this beginning was made, but as the effectiveness of collegiate training became recognized other state colleges organized ceramic departments until now there are ten in the United States and one in Canada specializing in ceramic science and engineering. There are, too, several schools devoted especially to ceramic art. It is fitting that there be a national celebration of the anniversary of the beginning of this organized training with due recognition to those practical men and scientists who by their individual efforts made possible this collegiate training.

It is fitting also that the American Ceramic Society should lend its support to such a celebration. And since Ohio State University is the place where this start was made, it is not only fitting but gracious that that University has extended invitations to ceramists, industrial, educational and research, to meet on its Campus during the week of February 16, to consider the values realized and the means of greater values which are possible.

Following are addresses made at the first meeting of the Ohio Ceramic Industries Association held January 16 and 17. These are so germane to this anniversary of the beginning of ceramic education, the celebration

of which the Ohio Association is sponsoring, that they are worthy to be included as a part of this anniversary number.

WHAT THE INDUSTRIES WANT FROM THE CERAMIC SCIENTIST

By Robert D. Landrum

My father once said to me, "Whenever your job is such that your are not learning something new each day, quit that job." Any ceramic industry that is not so organized that it is continually learning something new about the process which it uses, or the product which it is making, will sooner or later be forced to quit. The ceramic scientist should be the factor in such an organization, responsible for this continual accumulation of specific knowledge, the intelligence department, as it were, the catalyzer of progress.

Now just what do we mean by a ceramic scientist? And just how does he differ from the ceramic engineer? The term is rather new, and I expect that each of us here has a different conception of its meaning. In my mind, the distinction between the two is similar and almost parallel to that between the chemist, or better, the industrial chemist and chemical engineer.

It is difficult to distinguish sharply just where the attributes that make one man a ceramic scientist end, and those that make a ceramic engineer begin. In fact, I am somewhat of the opinion that the training of the ceramic engineer should be such that, first of all, he would be an embryonic ceramic scientist. The work of the two, the point-of-view, and generally speaking, the personal equation of the two, after they have been matured by experience in an undergraduate school, and by those rich years immediately following during which they have struggled to round off the corners and seek for their proper niche—are quite different.

The ceramic scientist will probably never be satisfied. One truth found and he's on the trail of another. Do not think for a moment that this seeking will not have in the background a desire to find a useful truth but, unlike the engineer, the thought of usefulness, or certainly the thought of immediate usefulness, will be in the background. The engineer in his proper niche will, in time, acquire the ability to take these truths that are found by the ceramic scientist, and apply them to the cheapening of process and the improvement of product.

I was tempted when given this subject of "What Do the Industries Want from the Ceramic Scientist" to play upon words and say that, as yet the average executive in our industry does not consciously want anything from him. This same executive, long ago, reached the point where he realized his need of the lawyer, his need of the investigator of markets

and the expert accountant, and will not today consider the cost of these, for he knows by experience that they are utterly necessary to his financial success and peace of mind.

Some time ago, it was to the point to say, "There's many a pottery without pyrometers, but none without adding machines." But, today, the absence of one is about as unusual as the other. The ceramic engineer has seen to this, and, today, he is thoroughly "sold" to our industries, and our schools are having a difficult time turning out ceramic engineers fast enough. In fact, the demand has been so strong that many men who should be doing the work that is waiting for the ceramic scientist, are working with production problems, or, perhaps, if more fortunately guided, are using their deductive ability in development work, regarding application of fuels, heat transfer, methods of mixing, milling, mechanical separation, filtration, hydraulic pressing, leaching, drying, etc.

The ceramic scientist has a creative mind, and if you do find him buried in routine work, you will find him impatient and dissatisfied, and probably satisfying neither himself nor those who employ him.

Even the work of the ceramic scientist can be divided into two classes: (1) The abstract search for fundamental truths, which is so slow and costly that the work will probably be carried on by endowed or government laboratories, and (2) the sound technical scientific work which must be carried out by or in coöperation with the industries themselves.

In further discussion of the subject, I will continue to refer to the ceramic scientist as the technical scientific worker, rather than the absolute scientific worker. Workers of the type of Mellor in England and Rieke and Simonis in Germany, are the sort that I like to consider as ideal ceramic scientists. And, of course, there are several in this country, too, but, for fear of missing some, I will not mention any.

This type of work, you can readily conceive, cannot be done by men whose whole time of preparation has been four college years. I do not mean to say that men with only four years actually in college, cannot be developed through their work after college, into scientists of this sort. We must remember that the thinker will see to it that his regular work is, as it were, postgraduate.

Most ceramic scientists, you will readily agree, are today found in the universities, the government bureaus, and in endowed laboratories. But the migration has started. In the chemical industries, this migration started much sooner than it has in our industry. And it has robbed the universities of their best instructors, and the bureaus of their key men. And the rewards of this have been such that today the schools are forced to examine with microscopic care, the attributes of the undergraduate, so that not a single boy with true scientific spirit and with creative ability will be missed.

These students are today carefully groomed for sound scientific work, and upon graduation, they are fairly fought for by the industries.

Get ready, Professors Watts, Parmelee, Brown, and you other heads of various ceramic departments of our schools. Our industries are next—for there certainly is a place for these ceramic scientists within the industries themselves. By this, I do not mean that each small plant must have its separate laboratory. But each must have a ceramic scientist that it can call its own.

Many of these men probably will work as fellows in the universities and technical institutes, some of them by special permission, in the government laboratories, many of them, we hope, in the laboratories of the separate industries themselves; the work of all perhaps linked and coordinated through some system of organization that will prevent duplication on problems of general interest; an organization that will guide each toward a definite end even on special problems.

Now I come to the real subject of my paper. And I am afraid you are going to be disappointed, not that my paper is going to be much longer, but because I am unable to show very much more need for the ceramic scientist in the industries newly called ceramic, than there is need for him in the strictly speaking clay working industries.

The very truths that we want the ceramic scientist to seek in the newly called ceramic industries are, for the most part, those that must be sought for in the clay working industries. Of course, the specific problems are different, but the general problems are one and the same.

While in the enameling industry we want the ceramic scientist's education to be such that he will know something of the fundamentals of metallurgy, nevertheless, his preparation must be such that he will have made a general survey of our ceramic information, that he can, and will have, as his chief goal, the determining of the physical constants which we need, and the creation of new conceptions of our materials and products.

The ceramic scientist must develop a system of the chemistry of the silicates, as complete and illuminating as the wonderful system of organic chemistry. Shall we call this system "ceramics," in the larger sense, and in keeping with our new definition of "ceramics?"

On first thought, it may seem peculiar that in industries as fundamental as ours, industries whose products are older than historical men, sound technical science has had so small a part, especially when we realize the remarkable perfection in craftsmanship which many products showed generations and generations ago. When we consider the matter carefully, however, it is not strange, for although our products seem simple, since they are made from familiar things (rocks, clays and minerals) and by seemingly simple processes, they are not. These same familiar raw ma-

terials are so complex that they almost defy analysis as to their chemical constitution.

This task which we are assigning to the ceramic scientist is an extremely difficult one. Yet, until we do develop this system of ceramics, which is neither chemistry nor physics nor mineralogy but includes all three as applied to silicates—we can only progress slowly and in a piece-meal fashion.

Searle, in the preface to his huge volume on the "Chemistry and Physics of Clays" just published, says, "Physicists have chiefly concerned themselves with matters in mass; chemists have dealt chiefly with the atoms and molecules of simpler and, therefore, more easily understood substances." He goes on to say that most manufacturers and users (of ceramic products) do not yet realize the enormous importance to them of chemists and physicists with highly specialized knowledge regarding this industry of ours.

I will go one step further and say that probably the physicist as such, and the chemist as such, will never work closely enough together to get the results we desire as quickly or as completely as the scientist I have tried to describe, who will be both, not a physical chemist,[1] but the ceramic scientist, who will overcome the difficulties, enumerated by Searle, due to the fact that it is difficult to obtain our materials in a pure form, that most of them are insoluble at the start, apparently inert at ordinary temperatures, and difficult to obtain in an easily recognizable form (such as crystals of convenient size).

This ceramic scientist, too, will be equipped to investigate the fundamental principles that Searle lists, which list many here can lengthen: effects of texture, causes and control of strength, distribution of water in partially dried articles, strains produced in drying and firing, causes and prevention of distortion, study of chemical equilibrium (almost impossible), size of particles and influence of this on chemical reactions and physical changes, the study of these at high temperatures, colloidal phenomena, plasticity.

I have already mentioned the physical constants (these I need not enumerate) and the determination of the true chemical constitution of our materials and products. Both the ceramic engineer and the ceramic scientist should be so well grounded in fundamental subjects that four years is all too short for the job. Both should, in my opinion, be given courses so that their undergraduate degree would simply be bachelor of science, with special proficiency in ceramics. Electives could well be offered after the freshman year, according to the bent of the student towards engineering of pure ceramics.

Let them become ceramic engineers or ceramic scientists after their postgraduate work either in the universities or in the laboratories, public

[1] *His* attributes are well defined and understood and his training would never give him the specialized knowledge which we require.

or semi-public, or in the industries themselves, of course, upon the submission of theses and professional records.

Then, too, for those who can afford three years of resident graduate work, a doctor of ceramics degree. It might be well to provide, also, for a complimentary degree, doctor of ceramic science, for those who have done unusual non-resident work.

As Professor Johnson said some four years ago, "The fundamental research which industry needs costs a lot of money, experience never being a cheap article, but the lack of it will be much more expensive to all of us. It is an insurance, an insurance against ignorance, and for the benefits obtained, the annual premium is very small, provided the work is put into the hands of properly qualified men."

This is what the ceramic industries want from the ceramic scientist: insurance against ignorance, a factor in their organization responsible for the continual accumulation of specific knowledge.

IDEAL COÖPERATION BETWEEN THE UNIVERSITIES AND THE INDUSTRIES

By A. P. Taylor[1]

Ideal coöperation between educational institutions and the industries would make itself felt within a few years in our whole economic structure. Advancements in manufacturing methods, developments in products, new inventions, and lowering of costs, will come rapidly by the application of scientific knowledge and control. Active coöperation between the ceramic industries and the universities is needed in order to make the best use of the information which is now available, to encourage original researches, and to determine the course of study which will produce men fitted in the best manner to serve the industry.

The function of the university is to add to our store of knowledge and to disseminate it through its own organization and the trained men which it produces. Its function would accordingly be promoted by an enlargement of its research activities, and were these directed toward the solution of problems of vital interest to the industry, a mutual benefit would result, which is the aim of any coöperative effort. In such work the industries must lend their united support, not only in a financial way but also in giving the attention to the work which it deserves, and in devising means for putting into practical application, the new ideas and new methods which result.

Coöperation with the industrial field through the establishment of research agencies is properly a work of the universities. They afford facili-

[1] Mgr., Charles Taylor Sons Co.

ties for obtaining expert advice in all branches of science, and insure unbiased efforts. There are already a number of schools maintaining organizations for industrial research, and the number is increasing yearly. Among these may be mentioned the Massachusetts Institute of Technology and the University of Pittsburgh. The Mellon Institute under the direction of the latter school has had singular success in industrial research. The fellowship maintained here by the Refractories Manufacturers Association has been in operation for eight years, and from a modest beginning has grown to be the most important of this Association's activities, and it is today indispensable to the refractories industry.

While ideal coöperation has been pictured here in the form of a research organization established by the university, fostered by the industry, and working toward the advancement of our knowledge of ceramics, it is probable that even closer contact between the university and the industry would be beneficial.

In many other lines we find consultants of recognized ability obtainable for the solution of engineering and technical problems. In the ceramic field it is difficult to obtain such assistance except on problems of rather general nature, and until this condition is changed, a decidedly beneficial service would be rendered by making expert consultants available.

The first suggestion for industrial research in this country was made by Felix Pascalis before the Chemical Society of Philadelphia in 1801. It is interesting to note that he urged research in ceramics "in the production of good earthenwares." Our lack of knowledge now is evidently not due to a lack of appreciation for the need of research in other years, but to our lateness in getting started.

Our fund of technical information on ceramics in this country has come within a few years. The beginning of our education along that line may be traced back to the institution of a ceramics department at the Ohio State University by Professor Orton. The growth of this branch of learning has been rapid, and will continue so long as the industries are able to be benefited by the information which is carried out to them.

The strides that have been made, and the benefits that have accrued to the industries, are the results of original investigations and research. This must be true, else our knowledge of ceramics would not have advanced, and a cursory comparison will prove the increase in our fund of information.

We have reached a highly competitive stage in all lines of industry, and unless a manufacturer makes a better product tomorrow than he is making today, he will soon be pushed aside.

Results in the past insure the success of a research project, and present conditions demonstrate the need. Our universities have an opportunity to be of invaluable assistance, by pointing the way toward greater econ-

omies and better products. By a united effort in this direction, we shall show the spirit of ideal coöperation.

THE DEVELOPMENT OF A CERAMIC COURSE TO MEET THE DEMANDS OF THE INDUSTRY

By Arthur S. Watts

The Ohio State University *Bulletin of the College of Engineering* of which the Department of Ceramics is a part states:

> The purpose of the College of Engineering is to instruct students in the fundamental sciences and arts, upon which all engineering rests and to impart such special and technical knowledge of the various branches of engineering as will enable its graduates to maintain themselves while gaining their professional experience.

This statement establishes two facts: (1) the ceramic course as provided at present is intended to produce ceramic engineers. (2) The university does not pretend to produce a finished product, but only to furnish fundamental knowledge.

The university does acknowledge that the training provided shall be such as will enable the graduate to earn his wages during his period of training in the industry, and not be a burden to his employer during that period. To the industrial or engineering world, the sciences of chemistry, physics and mathematics are recognized as fundamental and essential, and in view of the limited training in rhetoric and grammar which our public schools provide, it appears necessary that these be given some place in any college training. Beyond these, what fundamental knowledge would the ceramic industry be justified in demanding of a ceramic graduate, whether he be an engineer, an artist or a scientist?

In the consideration of raw materials, he should have the fundamentals of geology and mineralogy. In plant control and operation, he should have the fundamentals of mechanics, power generation, and power transmission. If he is to be useful in plant layout or development, a knowledge of drafting is necessary. To any educated man serving the ceramic industry, a knowledge of fuels and their combination is essential. All ceramic schools have found that these subjects are necessary regardless of the field of service into which their graduates go.

The university, therefore, has no choice but to insist that these subjects be properly provided for in its curriculum.

As a general assumption, we may say that all of the student's time, not required for the mastery of these fundamentals, should be devoted to such study as will equip him to serve the industry. The introduction of non-essential courses must be at the expense of the time otherwise devoted to ceramic instruction because educators have proved that to overload a student results in inferior training in all his work.

Most schools hold, however, that some non-essential courses are advisable because otherwise the student becomes lop-sided and cannot make proper contact with those outside his own field, and this opinion is strongly supported by all the large business organizations into which ceramic graduates go. Most schools demand a knowledge of surveying, and a majority demand training in foreign languages. In a majority of schools some time is allotted to the student's choice of subjects other than those prescribed.

In the five original ceramic schools, the essentials consume from 51% to 75% of the student's time, as indicated in Table I.

TABLE I

CERAMIC CURRICULA

Fundamentals	Ohio State %	Illinois %	Iowa State %	Rutgers %	Alfred %
Mathematics	14.0	13.3	15.0	11.5	13.5
Chemistry	13.0	16.2	14.0	17.0	15.5
Physics	8.0	8.0	9.0	4.0	8.5
English	4.0	4.4	6.0	6.0	1.5
Geology and Mineralogy	4.0	..	12.0	5.5	3.5
Mechanics—M.E. and E.E.	9.0	8.3	13.0	5.0	5.0
Engineering Drawing	7.0	6.0	6.0	3.0	3.5
Fuels	2.0	1.4	..	2.0	..
	61.0	57.6	75.0	54.0	51.0
Ceramics					
Ceramic Fundamentals	22.0	18.5	16.0	16.0	15.5
Ceramic Research	11.0	8.5	4.0	8.5	15.5
	94.0	84.6	95.0	78.5	82.0
Cultural and Electives					
Surveying	2.0	1.4	3.0	..	3.5
Foreign Language	..	6.0	..	10.0	8.5
Electives	4.0	8.0	..	8.5	4.5
Miscellaneous	..	..	2.0	3.0	1.5
	100.0	100.0	100.0	100.0	100.0

The allotment of the remaining time to ceramic fundamentals and research is also indicated in the same table. This brings us to the consideration of the subject before us. How can we best utilize this available time to meet the needs of the industry? The allotment of time to ceramic courses at Ohio State University is indicated in Table II.

No place is provided in the University schedule for manual training courses in ceramics or for a study of plant design and operation but these are provided for by the Ceramic Industrial Experience Courses and by the Plant Inspection Trips. The Industrial Experience Courses each require 10 weeks' plant experience in an approved plant, a written report of the work done and a statement from the employer that the services were satisfactory.

TABLE II

ALLOTMENT OF TIME TO VARIOUS CERAMIC COURSES AT OHIO STATE UNIVERSITY

Course No.		%
401	Origin, Occurrence and Phys. Properties of Clays, etc.	1.8
405	Mining, Preparation and Forming	2.2
601	Drying and Burning	2.2
605	Bodies, Glazes and Colors	1.8
610	Refractories and Test Furnaces	2.2
615	Ceramic Calculations	2.2
620	Testing of Clays, etc.	2.2
701 and 702	Research in Bodies and Glazes	4.4
703	Research in Colors	2.2
704	Research in Metal Enamels	2.2
705	Design—Plant Layouts	2.2
706	Design—Driers	2.2
707	Design—Kilns	2.2
710 and 711	Thesis—Research	3.0
		33.0

REQUIRED COURSES OUTSIDE CURRICULUM

430	Sophomore Summer Industrial Experience.
431	Junior Summer Industrial Experience.
630	Junior Factory Inspection Trip.
631	Senior Factory Inspection Trip.

The Plant Inspection Trips each require one week spent in visiting ceramic plants under the direction of an instructor and an examination covering the plant arrangement and processes observed. This course has been designed to produce ceramic engineers because the call has been for men with a broad ceramic training rather than for specialists.

The development of new curricula to produce ceramic artists and ceramic scientists or the modification of the present course to meet these needs and the alteration of our present curriculum to produce a better ceramic engineer are subjects that demand very serious consideration.

PRESIDENTIAL ADDRESS—1922[1]

BY FRANK H. RIDDLE

EDITOR'S NOTE: The presidential addresses by Mr. Riddle and Prof. Greaves-Walker would have appeared earlier had a YEAR BOOK been published. It has been found of more service to publish the YEAR BOOK items from time to time, hence a "YEAR BOOK" known as such will not be issued this year.

These two addresses are particularly pertinent now when we are this month celebrating the thirtieth anniversary of the beginning of ceramic education. Both of these addresses are germane to the purpose of this occasion.

[1] Presented at the Pittsburgh Meeting of the AMERICAN CERAMIC SOCIETY, February 12, 1923.

Introduction

The end of the year 1922 marks the close of an important year in the history of the affairs of the AMERICAN CERAMIC SOCIETY. First because it is the closing of the first quarter century of the life of the SOCIETY and second because it is the closing of the first full year of operation with a full time secretary in active charge of the execution of the affairs of the SOCIETY.

The First Quarter Century

It is fitting that brief mention should be made of some of the more important developments which have been accomplished during the life of the SOCIETY. Perhaps the most important result of the activities of the SOCIETY is the recognition of the ceramic engineer by engineers in other fields of endeavor. This is particularly true among the electrical, chemical and construction engineers. The second important point is the more general knowledge, by the public, of the broader meaning of the word ceramics. This recognition and general knowledge has, of course, been brought about largely through the wide distribution of the publications of the SOCIETY and other technical journals. These publications, however, have only been the media by means of which ceramic knowledge has been distributed and nothing could have been accomplished if it had not been for the untiring efforts on the part of many of the members of the SOCIETY in undertaking extensive researches and then being willing to impart their knowledge to others.

The ceramic researches which have had the widest industrial application and which have resulted in the saving of millions of dollars are those of Edward Orton, Jr., particularly his work on the "Rôle Played by Iron in the Burning of Clays." The facts brought forth in these researches are now such common knowledge that we are too apt to forget that the information was gained in the earlier days only after painstaking and exhaustive work had been done with the poor equipment available at that time and with little knowledge of fundamentals. We should be very proud of the fact that the man who has been so largely responsible for the founding of ceramic schools and the AMERICAN CERAMIC SOCIETY should also have been responsible for one of the greatest ceramic researches.

The development of refractories has also played an important part in the progress of a very wide range of activities. The improvements made in refractories are probably more keenly felt by the general public than improvements in any other ceramic product and the savings due to less interrupted production brought about by the improved refractories cannot be estimated. Improvements now in progress in refractories will unquestionably have a tremendous influence on further betterments where refractories are used to any extent.

The development and experimental stages in the construction and operation of continuous kilns have reached a point where it is safe to predict that periodic kilns are soon to be obsolete equipment and those who use them will be seriously handicapped in competition. It is interesting to know that the fuel saving is only one of several advantages of the continuous kiln over that of periodic kilns. The percentage of number one product and the uniformity of quality of this product have resulted in savings to the manufacturer as well as more satisfaction to the customer.

Every branch of the ceramic industry has shown marked improvement and it would be difficult to tabulate these improvements in the order of their importance. This question should not be passed, however, without making some reference to the improvement in architectural decoration which has been made possible through the coöperation of the architects and ceramic building material manufacturers.

The Year 1922

The year 1922 might be said to be an experimental year, the purpose of the experiment being to see if we had grown sufficiently to undertake larger and more expensive operations. This step was deliberately taken with the knowledge that it might be necessary to draw on the reserve unless we were particularly successful in the membership and advertising campaigns. Steps taken to assist in this work were the centralizing of all activities at Columbus with the exception of the advertising, the enlarging of the *Journal*, and the development of a more nearly complete abstract section and the publication of a *Bulletin*. The original plan was a semi-monthly *Bulletin* which would carry its own advertising and carry news which would be of particular interest to the plant operators and foremen and also provide a means of reaching out to interest prospects in memberships. This was abandoned after the first issue and issued monthly under the same cover as the *Journal*. It is not possible to predict whether the first method was better or not but it was felt by some that the advertising in the *Bulletin* would mean less advertising in the *Journal* and that the net result would be the same.

A summary of the year's work shows that our income was not great enough to take care of our expenses and that it has been necessary to withdraw some money from our reserve. The receipts from advertising, which source was counted on largely to meet our needs, were not as great as some of us felt they should be, considering the increase in circulation and changes in the character of the combined *Journal* and *Bulletin*. The accompanying table shows the relative financial growth in receipts and expenses during the years 1920, 1921, and 1922.

THREE YEAR COMPARISON OF INCOME AND EXPENSES

RECEIPTS

	1920	1921	1922
Dues	$9606.85	$11342.10	$15518.31
Advertising	5259.00	7864.55	12648.50
Other sources	2803.10	3087.35	3394.81
	17668.95	22295.00	31561.62

EXPENSE

	1920	1921	1922
Journal, Printing, Abstracts, Drawings, etc.	$8134.65	$10827.96	$15050.52
Advertising Commission	....	1345.08	2819.99
Other *Journal* Expense, Including Salaries	2558.47	3400.03	2754.83
Secretary's Office, Salaries	2199.96	4554.94	9197.08
Office Expense	781.17	2106.08	3060.40
Committees and Divisions	643.44	781.70	1947.51
Traveling	711.53	1023.00	1145.60
Meetings and Incidentals	622.66	2104.79	1908.55
	15651.88	26143.58	37884.48

NET INCREASE IN MEMBERSHIP

	1920	1921	1922
Personal	124	199	289
Corporation	15	46	79

The receipts for 1923 will unquestionably be greater than those for 1922 as we will have at least a normal growth in membership and fully expect an increase in advertising. This expectation is based on an investigation of the volume of advertising handled by some of the trade journals during the past year. We have been informed through reliable sources that most trade journals suffered a substantial loss on advertising during 1922 as compared with previous years. If this is so, we have no cause for complaint as our advertising receipts show a substantial gain in 1922. If we receive the same increase in 1923 that other journals are anticipating, we can also look forward to an increase particularly in view of the general good financial condition of the country.

During the past year, the advertising has been handled entirely from the Atlantic Coast. However, during the past month arrangements have been made to handle it through the Columbus office, arranging to have local solicitors throughout the country. How successful this system will be cannot, of course, be determined for some time to come. However, it places the advertising directly in our own hands and also gives us a wider field in which to solicit advertising. It is therefore reasonable to expect an increase in revenue.

The growth in membership has been very substantial, the gain over last

year being 20%. Best of all a foundation has been laid for further growth particularly in corporation memberships.

The exhibit of ceramic products at St. Louis was a success and the increase in interest in the present exhibit clearly shows the possibility of creating a new source of revenue to help meet our expenses. If we expect to keep abreast of the times, we must know what others are doing and an exhibit is justified for this if for no other reason. If revenue can be derived at the same time we should not neglect the opportunity as we can not only rent space but also increase the advertising in the *Journal*.

The Full Time Secretary

The results of the last year's work have shown that we were justified in employing a full time general Secretary-Editor, and I wish to express my appreciation to not only Mr. Purdy, but also to Miss Binns, the Assistant Secretary, and Miss Van Schoick, the Assistant Editor.

The team work which has been created in Mr. Purdy's office has been a great help to the SOCIETY and we are indeed fortunate in having a corps of enthusiastic hard workers so vitally interested in our affairs. Mr. Purdy has worked ceaselessly and I am sure that by the end of 1923, we will have the SOCIETY in a strong financial position.

The movement started last September to have all Divisions represented on the Board of Trustees is a good one and should be carried through as rapidly as possible. This will necessitate the first Trustees from the various Divisions being elected for different terms of office so as to start off properly with the overlapping term plan that has been used in the past.

As previously stated, the past year was, to a certain extent, an experimental year insofar as expenses were concerned. It is reasonable to expect that the income for 1923 will meet the expenses which will be about the same as those of 1922. [However, I wish to urge that the SOCIETY adopt the policy this year of living within our income and not drawing on our reserve.] The Secretary's office is so organized and his work so arranged this year that he will have considerable time for field work strengthening Local Sections and creating new ones. This being the case, we can expect our income this year will be all that our organization can reasonably expect at the present time. Bearing this in mind, we should consider our present average expense as the maximum for the present and live within this limit, maintaining our reserve as far as possible for emergencies.

Future Progress

In reviewing previous presidential addresses, the suggestions for future progress are so well covered that it is difficult to make any new suggestions. However, past presidents have brought out some very important points which should be emphasized.

New Divisions

The Society has never encouraged the discussion of mechanical equipment largely because it has to be done by the manufacturers and hence appears to be too much like advertising. Clay working machinery and equipment has been criticized as compared to that developed in other industries. If this criticism is justified, we would be warranted in attempting to create more interest in mechanical developments and should seriously consider how best to accomplish this. We all know that the greatest labor saving is accomplished by means of mechanical devices and it is important that our operating costs be lowered if we expect to compete, particularly if we export.

Standardization

This subject is extremely important but has been brought up so often that it need only be mentioned here. So little work need be done to complete and compile the work already accomplished that this should be done in the near future. We can capitalize on this work in our membership work as well as in adopting standard tests for our own use and comparison with other investigators' work.

Ceramic Hand Book

The compilation of a ceramic hand book should also be undertaken. Considerable data is already available and could be collected with comparative ease if the Society as a whole would undertake the work. The work of preparing a text book, as already undertaken by the Art Division, represents a great deal more work than the preparation of the hand book and yet undoubtedly will be accomplished with great success.

A hand book which could be used by engineers in general would bring us to the attention of the technical world in a way that nothing else would, and would not only strengthen our position but also be a real help in the engineering field.

Ceramic Education

Ceramic interests can best be served by developing three classes of trained ceramists. These men should be developed in two classes of schools. The first class should be developed in trade schools. These schools would naturally be placed in ceramic centers and their aim would be to interest and develop the young clay workers in semi-technical lines at the same time they served their apprenticeships. This would develop these men for positions as foremen and ceramic routine men and thus not only better their conditions but also give them a better understanding of and a willingness to coöperate with the executives and technical staffs.

The second and third classes should be made up of high grade men thoroughly trained in ceramic engineering courses of the highest standing.

The tendency in all engineering colleges at the present time is to turn out a great number of graduates and thus overcrowd the industries with indifferently trained men. This should be avoided in ceramic engineering courses particularly if the trade schools are developed to the point where they should be.

Technical training in the ceramic courses should be carried out with a view of training the capable students who are able to carry on with the work, and developing two classes of men. One, those who will be capable of carrying on high grade research work, and two, those who will eventually be capable of becoming plant executives. This would necessitate at least a five-year course. The students would develop sufficiently in the first three years so as to decide which of the two branches of ceramics to specialize in during the next two years.

As long as plant foremen are uninterested in any knowledge of ceramics and plant executives are developed from office employees, who have no technical understanding of ceramics, the ceramic engineer cannot expect to develop the industry as he should. If he leaves school with the purpose of accomplishing some improvement based upon sound engineering principles in which he has been thoroughly grounded, his efforts will be successful. The other class of trained men will also accomplish something, as they will leave school with the knowledge that the executive is in a better position to get results than anyone else in a manufacturing organization, and they will work toward the executive positions, applying their ceramic knowledge as they go and eventually becoming broad-minded, well balanced men, capable of handling affairs in the best possible way.

Conclusions

I wish again to emphasize the fact that the most valuable assets we have are our publications and that these should always be considered first and be given preference over all other interests. I feel that any progress made the last year has been largely due to the enlarging of the scope of the *Journal* and the decision to foster new publications such as the Refractories Bibliography, and the Art Division Text Book. Work of this character should be continued.

In closing, I wish to express my thanks and appreciation for the confidence placed in me by the members of the SOCIETY in honoring me with this office.

I want to thank the Board of Trustees for their enthusiastic willingness to be of service at all times. Also the members of all committees and Division and Section Officers. We cannot expect to accomplish anything without this coöperation on the part of all. Friendly criticism and suggestions should be given and taken at all times and if this is not done, we will not grow and broaden as we should. I wish particularly to thank the

Secretary and his force for the splendid coöperation they have shown and the hard work which they have done. Also my secretary, Miss Grace Wohlfelder, who has taken an active interest in carrying on the work. In retiring from office, I wish to express my desire and willingness to assist the SOCIETY in every way possible.

THE PRESIDENTIAL ADDRESS—1923[1]

BY A. F. GREAVES-WALKER

This year marks the twenty-ninth anniversary of the birth of ceramic education in this country, the first ceramic department being organized at Ohio State University by Edward Orton, Jr. in 1894. Ceramic schools organized along trade school lines had been known in Germany for some years previous to that date, but it remained for Dr. Orton to put ceramics in all of its various branches on an engineering basis. Little did he think that within twenty-nine years there would be ten departments scattered from Coast to Coast, and practically all modeled after his at the time of his retirement from active teaching.

The Ceramic Schools

It is interesting, instructive, and somewhat surprising to note the following data with reference to the departments now in existence.

Ohio State University
Columbus, Ohio

The course in Ceramics was first offered in 1894 as a two-year short course. In 1896 a full four-year course leading to a degree was offered.

To date this department has turned out 244 men in both courses, 171 having received degrees. It is worth noting that during the last ten years, 81 students have received degrees while but five have finished special or short courses, whereas during the first ten years of its existence this school granted ten degrees while 43 finished short or special courses.

Alfred University
Alfred, New York

In 1900 Alfred University started the New York State School of Clay Working and Ceramics under the direction of Professor Charles F. Binns. This department offers a full engineering course leading to a degree, and has also specialized in art pottery and decorative ceramics, in which it has specially interested the women who are doing such good work in the preparatory schools of the country.

Unfortunately, statistics covering the number of students graduated are not available.

---

[1] Presented at the Atlantic City Meeting of the AMERICAN CERAMIC SOCIETY, Atlantic City, N. J., February, 1924.

Iowa State College Ames, Iowa A course in Ceramics was established at Ames in 1901. This course led to a degree. Development of this department has been rather slow but it has sent out into industry some splendid engineers.

Thirteen men have received degrees from this college. Six will receive degrees this year.

Rutgers College New Brunswick, New Jersey In 1902 a ceramic school was established offering a full engineering course leading to a degree. This department has grown steadily if not rapidly. In this case also, statistics were not available.

University of Illinois Urbana, Illinois In 1905, the University of Illinois instituted a a Department of Ceramics. This department has had rapid growth due principally to the strong support given it by the clayworkers of the state. A full engineering course is offered, leading to a degree.

To date this department has granted degrees to 95 men. It has also granted eight Master's and three Doctor's degrees.

Since 1913 this department has offered a two weeks' Short Course bi-annually. To date, 270 people interested in Ceramics have attended these sessions.

University of Washington, Seattle, Washington A ceramics department was organized at this University in 1918, the first on the Pacific Coast. Teaching was not started until 1920. Since that time one graduate has received a Bachelor's degree, and three graduates, Master's degrees. Two students finished special courses last year.

University of Saskatchewan, Saskatoon, Canada A department of ceramics was organized at this school in 1921 by Professor Worcester, one of Dr. Orton's first students. The course leads to an engineering degree. Two students, the first to enter the department, will graduate this year.

Three new ceramic departments are being established this year, two of them in the South. One of these is at Georgia Tech, Atlanta, one at North Carolina State College, Raleigh, and the other at Penn State, State College, Pa.

Thus on the twenty-ninth anniversary of the establishment of the school at Columbus, we have ten ceramic departments offering engineering degrees or the equivalent. These schools have sent into the various branches of the industry 350 engineers having degrees, approximately 150 men who have finished short or special courses and a considerable number of men who have received some training but for various reasons have not finished.

The curricula leading to degrees at the various schools have been very much alike basically. There have naturally been some variations, and

cases where emphasis has been put on some subjects more than others. In the main, however, it can be assumed, especially in late years, that the average graduate from each of the schools should be on a parity, in fact, actual comparisons show this to be pretty much the case.

It is needless to go into a discussion, before the members of this SOCIETY of the question as to whether the curricula laid out for ceramic students are properly designed. It is a question on which there is very little likelihood of agreement. Suffice it to say that even ceramic educators themselves are not entirely satisfied that they have reached the ideal. After all, it is not so much what subjects a man takes as how they are given to him, in other words, much depends on the instructors.

My purpose in this address is not to criticize our schools or their methods, but rather to analyze the men they are turning out, with special emphasis on those men who go into the operating departments.

The Encyclopedia Britannica defines a technical education as the special training which helps to qualify a person to engage in some branch of productive industry. It may be assumed then that our schools aim to give all the help possible to fit a ceramic engineer to take his place in industry, and it might also be assumed, with the least possible expense to his first employers.

I think it will be agreed that the task of developing a ceramic engineer is far more difficult than that of developing a mechanical, electrical, mining or civil engineer.

The latter branches of engineering have been taught so long that the educators have a well defined idea of what will be expected of the graduates, and, furthermore, the employers know what to expect of them.

In the ceramic industry, with its wide ramifications, there is such an immense gap between the requirements of an engineer in a spark plug plant, and a refractories engineer in a steel or copper plant, or the chemist of an optical glass plant, that it is difficult to train in more than fundamentals.

The question that occurs to many of us is whether sufficient stress is being laid on those fundamentals which will most quickly "sell" the graduate to his employer, and at the same time give him the shortest road to financial success.

During my service in the industry, I have had a splendid opportunity to study at close range, twenty-two men who have come to me directly from school. They were representatives of all but one of the older departments, and I believe, average representatives. All of these men preferred the operating to the laboratory or purely technical side of plant work.

When taking a young ceramic graduate into my employ, I have expected to find in him the following qualities:

(1) Accuracy.

(2) Absolute loyalty.

(3) A willingness to do whatever he was told.

(4) At least a sufficient knowledge of mechanics and things mechanical to warrant his title of engineer.

(5) A sufficient knowledge of psychology to allow him to understand labor.

(6) A working knowledge of drafting and designing.

(7) A knowledge of the chemistry and thermodynamics of fuel burning.

Somehow to the average man "accuracy" and "engineer" are synonymous. We can hardly think of an engineer as being inaccurate. I suppose we must assume that to a large extent a student's grades are a measure of his accuracy and that he must be fairly accurate to graduate.

From my personal experience, however, I am strongly of the belief that our schools are not impressing upon their students that "fairly accurate" will not do in industry. Very few of the young men I have come in contact with could, for example, be trusted to measure accurately pulley centers, and figure a belt length; get accurate data on a set of gears; or take an inventory, for months after they were employed and then only after constant criticism. Accuracy holds such an important place in any branch of modern business that it naturally occurs to one that a student should be so saturated with it that when he does leave school it will not be necessary to further impress its importance upon him. If it is possible to train a graduate to be accurate in from six to twelve months, is it not possible to train an undergraduate in four years?

I have never had the experience of having associated with me a disloyal college graduate. This may have been due to the kinship that one college man nearly always feels for another. Ceramic graduates, however, have often been placed in trying positions that have strained their loyalty to their superiors or employers to the breaking point. When such a point is reached, a man must be of fine fiber to be of further service. Loyalty is not included in the curriculum, but the ideal educator gives his students many things not so included.

Instances of the outcropping of disloyalty in graduates I have attributed to a lack of real knowledge of what was to be expected in the business world. I have often thought that great good could be derived from a series of lectures or talks by the older alumni during the senior year.

I have sometimes been brought, in my experience, to a point where I was inclined to agree with those opponents of a college education who maintain that many good men are ruined or partially ruined by it. Four years of easy campus life is not the best training in the world for an industry which operates twenty-four hours a day, and three hundred and sixty-five days in the year. In most cases the young graduate has a rude awakening

when he finds there are no more Saturdays, few Sundays, and that Thanksgiving and July 4th look like any other day in the year in many clay plants.

I cannot but feel that the failure on the part of graduates to grasp what industry will demand of them is due to a lack of proper training while in college. One thing is very noticeable, and that is that those men who have been trained by educators who have themselves been in the operating departments seem to go through the transition much better than others.

Every ceramic department has a few units of clay-working equipment, and yet it is surprising how little the average graduate knows about the equipment his training compels him to work with.

Every ceramic curriculum, I believe, provides for some training in mechanical engineering including the fundamentals of boiler, engine, and electrical apparatus construction and operation, also some training in forging and machine shop practice. From my own observation, I have been compelled to conclude that the value of this work is either insufficiently stressed or the work itself is slighted.

Undoubtedly, the forming of the great bulk of ceramic products has become mechanical, so much so in fact, that in the heavy clay products lines there are a greater number of failures due to the inability of the operators to keep up properly mechanical equipment than to inability to make a salable product. Many graduates having a splendid grounding in ceramic fundamentals have failed in their initial efforts because they were not well grounded in mechanical fundamentals. All the knowledge of glazes and glazing which a graduate might possess would not be one-tenth as valuable to him on a heavy clay products plant as the knowledge that a dry pan cannot be held together unless the bolts are equipped with lock washers or lock nuts, or that unless an elevator is operated at proper speed it will choke and cause constant shutdowns.

It seems almost absurd to employ an engineer who is not sure of the correct names of clay-working machines with which he is to work, and understands little or nothing of the principles upon which they operate. The same young man can invariably show some very good specimens of glazed pottery which he has turned out and which in later years prove to be constant reminders of time wasted.

Of equal importance to the mechanical side of ceramics is the ability of the young graduate to understand and direct labor. I have always been a strong believer in a thorough course in psychology as the best preparation possible for the man who aspires to an executive position.

Ceramic graduates are demanding and receiving salaries equal to department foremen, and whether employers are justified or not, they expect a college man to be able to handle a gang of laborers as well as or better than the average practical man. Executive ability may be a gift in some men, but I am convinced it can be acquired by others.

As success or failure today depends so largely on the labor factor it is of prime importance that operators know how to get the greatest efficiency from their men.

No course of training can be given a man in college, but a thorough grounding in psychology will go a long way toward giving him the right start.

Some of the departments are giving their students splendid courses in drafting and ceramic plant design, and the chemistry and thermodynamics of fuel burning, others are slighting these subjects. Too much stress cannot be laid upon the value of these subjects to the graduate who would become an operator.

I believe that the majority of our ceramic educators are agreed that the present curricula can be improved upon and that more time must be devoted to engineering fundamentals by students who intend to enter plant work.

It has been suggested that the curricula in all the departments be divided at the end of the sophomore year into science and engineering as is done at Illinois, except that there be even more concentration in engineering on those subjects which are closely related to plant control and administration. Such a course should cover at least 60% engineering fundamentals and practice. The ideal curriculum might even require the addition of a year for specialization, making five years, but this should be avoided if possible on account of the increasing cost of education and the crowded condition of the colleges.

Certain it is that scarcely a graduate can be found who has gone into plant work who does not severely criticize the present ceramic courses. If these men, who are the ones most interested, and the ones who are "buying" an education, are dissatisfied, is it not time for those in control of our educational institutions to awake to the fact that the present order of things must be changed?

WILLIAM LLOYD EVANS

America's First Collegiate Instructor in Ceramic Chemistry

When "Billy" Evans was instructor in ceramic chemistry the titles of Doctor, Major and Professor were not dreamed of. He was just "Billy" then and to the pupils now grown grey he is still just "Billy."

Professor Orton's budget did not permit employing a chemist the first year of the world's first collegiate department of ceramic education but in the second year he was able to employ an instructor, hence the advent of "Billy" Evans.

Analyzing of silicates is difficult today. Much more so was it thirty years ago when methods and reagents were less developed. Billy started his teaching when the chemical world was fast learning how to make silicate analysis, hence a merry time that first class had with their instructor. Trained with America's first ceramic chemist,

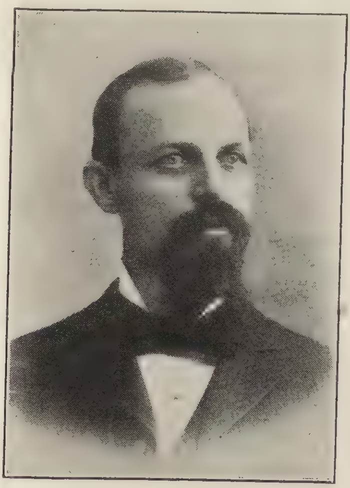
Karl Langenbeck, and further coached by that thorough chemical technician, Edward Orton, Jr., Billy was able to keep in the lead albeit closely pursued by his pupils.

This our "Billy," we present as America's first collegiate instructor of ceramic chemistry. Celebrating as we are this month, the beginnings of collegiate ceramic education, it is fitting that we, the first pupils, should want our "Billy" on the map.

WILLIAM LLOYD EVANS

He was born December 22, 1870, Columbus, Ohio. Public school education in Columbus, graduated at Ohio State University, 1892, with B.Sc. degree; M.Sc. in 1896 from same institution; Ph.D. from the University of Chicago in 1905. Was assistant chemist to Karl Langenbeck, American Encaustic Tiling Co., Zanesville, Ohio, 1892–1894. Assistant in Department of Ceramics under Professor Edward Orton, Jr., Ohio State University, 1896–1898; teacher in Chemistry in Colorado Springs High School, 1898–1902; Assistant Professor of Chemistry, Ohio State University, 1905–1907; Associate Professor, 1907–1911; Professor of Chemistry, since 1911.

Entered the Ordnance Department, United States Army as Captain in October 22, 1917. Transferred to Chemical Warfare Service after the organization of this service, being promoted to the rank of Major, July 20, 1918. While in the service he was given the responsibility of building, organizing, equipping, and operating Chemical Laboratory, Edgewood Arsenal, Edgewood, Maryland, and was the scientific and executive head of the Laboratories and Inspection Division, Offense Division, Chemical Warfare Service, Edgewood Arsenal, at the time of the signing of the Armistice.



JAMES H. GOODWIN

JAMES H. GOODWIN

James H. Goodwin gave Professor Orton a large amount of very effective assistance in aligning the Ohio general ware manufacturers and presenting claims to the state legislature in support of the proposals of a school of ceramics at the Ohio State University. It was the personal approval and active backing of such men as James H. Goodwin that made possible the beginning of collegiate ceramic education in America.

Mr. Goodwin was born in East Liverpool, Ohio, July 3, 1846, and died Nov. 4, 1896. His father was John Goodwin from the Staffordshire district, England. John Goodwin, the father, began manufacturing yellowware and rockingham in East Liverpool in 1842, four years before the birth of James. With his brothers George S., and Henry S. Goodwin, James began the production of whiteware in 1876.

In addition to his support of Professor Orton's scheme for a ceramic school we are indebted to James Goodwin for having introduced the use of the pugmill. Prior to his obtaining a pugmill used in a paper pulp mill in Wisconsin they used the horse propelled "chaser pan."

It is said of James H. Goodwin that he was at all times ready to give information and assistance to his competing potters. He believed his business would not be harmed nor made more difficult if all potters made as excellent ware as was possible from their pooled experiences and knowledge. His ideals and practices were the same as those which have made this Society successful.

We acknowledge our obligation to the broad generous vision and helpfulness of James H. Goodwin. It is in keeping with his helpful spirit that his son Charles F. Goodwin is serving as Secretary of the U. S. Potters Association.

ACTIVITIES OF THE SOCIETY

OUR 1924 FISCAL RECORD

In the accompanying sheets are statements of the financial affairs of the SOCIETY. The SOCIETY operated during 1924 within the prescribed budget and at a financial profit.

After depreciating the inventories, paying all known charges, and not including any unpaid membership fees, the surplus, representing profits, furniture and inventories is $10,379.60.

The SOCIETY realized a net profit of $2929.12, of which $400 is cash and $2529.12 readily collectable accounts receivable.

Charged to this year's business is $970.05 representing the net cost to the SOCIETY of the Silica and Magnesite Refractories Bibliographies and $698.55 for the printing of the 1922 *Journal* Index. These two items, totalling in cost $1668.60 represents services rendered in excess of what was expected by the members.

A large item of financial loss as well as being a large loss in effectiveness is represented by $2183.05 dues for 1924 not received. This large non-payment of dues is regrettable more because it represents a loss in contacts and opportunities for extension of service. The SOCIETY needs the support of these delinquent members more for what they represent in opportunity to spread and to obtain information than for the fees they have not paid. Then, too, with the fees they should have paid, the SOCIETY could have extended its activities, supported research activities and in many ways better carried out the purposes for which it is maintained.

Rather than pride in the things accomplished the members should seriously consider what this loss in members means. Prompt payment of membership dues on receipt of statement insures continued service to the member and less expense to the SOCIETY. The money used in collecting delinquent dues would go quite a way in support of a research activity, the value of which would exceed the dues collected.

Our membership record for 1924 is as here shown. This record has been maintained without any special drive or urging.

	Personal				Corporation			
Time period	Beginning	Loss	Added	Net standing	Beginning	Loss	Added	Net standing
Dec. 15–Jan. 15	1959		31	1990	290		6	296
Jan. 15–Feb. 15	1990		41	2031	296		8	304
Feb. 15–Mar. 15	2031	68	29	1992	304	5		299
Mar. 15–Apr. 15	1992	7	35	2020	299	2	3	300
Apr. 15–May 15	2020	214	25	1831	300	13	4	291
May 15–June 15	1831	13	18	1836	291		3	294
June 15–July 15	1836	1	14	1849	294		3	297
July 15–Aug. 15	1849	1	9	1857	297			297
Aug. 15–Sept. 15	1857		9	1866	297			297
Sept. 15–Oct. 15	1866	2	17	1881	297		2	299
Oct. 15–Nov. 15	1881	2	11	1890	299		2	301
Nov. 15–Dec. 15	1890	3	11	1898	301			301
Net Loss				61				
Net Gain								11
Delinquent for 1924		213				6		
Members in good standing Jan. 1	1685				295			
Dec. 15–Jan. 15	1898	29	24	1893	301	7	1	295

The SOCIETY must strive to hold our members and to obtain more, not to have numbers but to increase the service contacts. If the services rendered by the SOCIETY is worth to the few what it costs in money and effort the worth of these services would be increased additively with each increase in number of members.

AMERICAN CERAMIC SOCIETY

CASH ACCOUNT

January 1, 1924 to December 31, 1924

RECEIPTS			
Free Balance in Bank January 2, 1924		$ 4,076.66	
Accounts Receivable Paid		1,647.88	
Advertising, Refractories Bibliography		303.00	
1925 dues paid in advance		5,646.06	
1925 JOURNAL paid in advance		883.94	
Advertising 1924 JOURNAL		14,068.55	
Dues 1924		14,526.52	
Publications Sold:			
Collective Index		17.62	
Journals		2,733.33	
Seger's Collected Writings		124.50	
Volumes Transactions		222.50	
Report Committee on Standards		27.80	
Reprints		766.09	
Interest		199.75	
Meeting expense refunded		28.44	
Postage refunded		12.50	
Traveling refunded		350.00	
Miscellaneous		30.11	45,665.25
DISBURSEMENTS			
Office equipment purchased		166.45	
Checks returned		18.20	
Printing Refractories Bibliography		1,226.00	
Stenographic help on Clay Bibliography		100.00	
Dues and JOURNAL refund		138.45	
Division expense:			
Art		190.45	
Enamel		229.55	
Glass		159.67	
Heavy Clay Products		191.63	
Refractories		301.68	
Terra Cotta		161.21	
White Ware		194.30	
Advertising expense		1,662.01	
1924 JOURNAL, Cost		15,790.62	
Abstracts, Cost		523.29	
1922 Index, Cost		698.55	
Reprints, Cost		1,780.92	
Seger's Writings, Cost		78.71	
Volumes Transactions, Cost		20.00	
Salaries		11,313.78	
Office Expense			
Secretary		3,352.34	
Editor		1,017.33	
President		34.25	
Treasurer		5.15	
Traveling	813.03		
Traveling refunded	350.00	1,163.03	
Meetings		1,550.84	
Committee expense		42.88	
Art Exhibit		183.21	
Miscellaneous		141.75	42,436.25
Balance in Bank			3,229.00
			45,665.25

This is to certify that I have checked all receipts (both direct and from the General Secretary) as shown by the Treasurer's Cash Book and have traced them through the deposits into the bank and all disbursements represented by vouchers except those outstanding have been carefully checked as to amounts and official signatures and found correct.

ASA J. HATCH, *Public Accountant.*

AMERICAN CERAMIC SOCIETY

BALANCE SHEET

December 31, 1924

	Trial Balance		One Year		January 1, 1925	
	Dr.	Cr.	Loss	Gain	Assets	Liabilities
Cash in Bank	3,229.00				3,229.00	
Cash, petty	300.00				300.00	
Liberty Bonds	4,700.00				4,700.00	
Furniture and Fixtures	1,119.33		111.93		1,007.40	

Balance Sheet (*Continued*)

	Trial Balance Dr.	Trial Balance Cr.	One Year Loss	One Year Gain	January 1, 1925 Assets	January 1, 1925 Liabilities
Accounts Receivable:						
Adv. Journal 1,986.60						
Adv. Bib. 99.00						
Pubs. 444.20	2,529.80				2,529.80	
Prepaid Expense, Clay Bib.	100.00				100.00	
Prepaid Dues, Personal...		3,069.16				3,069.16
Prepaid Dues, Corp'n.....		2,057.50				2,057.50
Prepaid Dues, Divisions...		511.90				511.90
Prepaid Journals.........		873.84				873.84
Divisions:						
Art..................	190.45	70.05	120.40			
Enamel...............	229.55	309.93		80.38		
Glass................	159.67	262.42		102.75		
H. C. P..............	191.63	239.88		48.25		
Refractories.........	301.68	392.76		91.08		
Terra Cotta..........	161.21	114.00	47.21			
White Wares..........	194.30	580.68		386.38		
Income:						
Advertising..........		15,986.90		15,986.90		
Dues—Personal........		14,895.52		14,895.52		
Dues—Corp'n..........		6,526.00		6,526.00		
Coll. Indexes........		19.12				
Coll. Indexes Inv.......	120.00			17.92	118.80	
Journals 1918–1923.....		621.11				
Journals 1918–1923 Inv.	4,202.80			446.51	4,028.20	
Journal 1924..........		2,783.74		2,783.74		
Reprints..............		1,031.71		1,031.71		
Seger's Writings........		124.50		124.50		
Transactions...........		272.50				
Transactions Inv.......	715.00			182.50	625.00	
Rep. Com. Std.........		35.05				
Rep. Com. Std. Inv.....	85.00			27.05	77.00	
Interest on Lib. Bonds..		199.75		199.75		
Miscellaneous..........		38.69		38.69		
Expenses:						
Adv. Comm............	1,662.01		1,662.01			
Jour. 1924 Printing....	15,790.62		15,613.82			
Jour. 1924 Inv.........					176.80	
Abstracts..............	523.29		523.29			
1922 Indexes Printing...	698.55		698.55			
Reprints..............	1,780.92		1,780.92			
Seger's Writings........	78.71		78.71			
Vol. Trans.............	20.00		20.00			
Bib. Refractories.......	1,372.05	402.00	970.05			
Salaries...............	11,313.78		11,313.78			
Office Exp. Sec'y........	3,339.84		3,339.84			
Office Exp. Editor......	1,017.33		1,017.33			
Office Exp. Pres.&Treas.	39.40		39.40			
Traveling Expense......	813.03		813.03			
Meetings Expense......	1,522.40		1,522.40			
Committee Expense....	42.88		42.88			
Art Exhibit Expense....	183.21		183.21			
Miscellaneous Expense..	141.75		141.75			
Profit for year...........			2,929.12			10,379.60
Surplus................		7,450.48				
	58,869.19	58,869.19	42,969.63	42,969.63	16,892.00	16,892.00

AMERICAN CERAMIC SOCIETY

Loss and Gain Statement

January 1, 1924 to December 31, 1924

GAINS

Earned Dues			21,421.52
Indexes Collective			17.92
Interest on Liberty Bonds			199.75
Miscellaneous			38.69
Net Gain on Divisions			541.23
Journals 1918 to 1923, Sales		621.11	
Less decrease in inventories		174.60	
Net Gain			446.51
Journals 1924, Sales		2,783.74	
Advertising	15,986.90		
Less Commission	1,662.01	14,324.89	
Total		17,108.63	
Printing	15,613.82		
Abstracts	523.29	16,137.11	
Net Gain			971.52
Seger's Writings, Sales		124.50	
Cost		78.71	
Net Gain			45.79

GAINS (continued)

Vol. of Transactions		272.50		
Cost	20.00			
Less decrease in inventory	90.00	110.00		
Net Gain			162.50	
Reports of Com. on Standards, Sales		35.05		
Less decrease in inventory		8.00		
Net Gain			27.05	23,872.48

LOSSES

Reprints—Cost	1,780.92		
Sales	1,031.71		
Net Loss		749.21	
Bibliographies, Refractories—Cost	1,372.05		
Income	402.00		
Net Loss		970.05	
Printing 1922 Indexes		698.55	
Expenses:			
Salaries	11,313.78		
Office Expense—Secretary	3,339.84		
Editor	1,017.33		
President and Treasurer	39.40		
Traveling Expense	813.03		
Meetings Expense	1,522.40		
Committee Expense	42.88		
Art Exhibit Expense	183.21		
Miscellaneous Expense	141.75		
Total		18,413.62	
Depreciation on Furniture and Fixtures		111.93	
Total Net Losses			20,943.36
Net Gain for Year			2,929.12

AMERICAN CERAMIC SOCIETY

FINANCIAL STATEMENT

January 1, 1925

ASSETS

Cash in Bank		3,229.00		
Cash, Petty		300.00	3,529.00	
Liberty Bonds			4,700.00	
Accounts Receivable:				
Advertising, JOURNAL		1,986.60		
Advertising, Bibliographies, Ref.		99.00		
Publications		444.20	2,529.80	
Furniture and Fixtures		1,119.33		
Depreciation 10%		111.93	1,007.40	
Inventories—Publications:				
Indexes, Collective	1,188 at 10 cents	118.80		
JOURNALS 1918–1923	40,282 at 10 cents	4,028.20		
JOURNALS 1924	1,768 at 10 cents	176.80		
Vol. Transactions	250 at $2.50	625.00		
Reports Com. Stds.	770 at 10 cents	77.00	5,025.80	
Prepaid Expenses—Clay Bibliographies			100.00	
Total Assets				16,892.00

LIABILITIES

Notes Payable		none	
Prepaid Dues—Personal	3,069.16		
Corporation	2,057.50		
Divisions	511.90	5,638.56	
JOURNALS		873.84	
Total Liabilities			6,512.40
Surplus January 1, 1924		7,450.48	
Gain for year 1924		2,929.12	
Surplus—Assets over Liabilities—January 1, 1925			$10,379.60

THE SOCIETY WANTS CERAMIC WORKERS

Twenty-four personal members and one corporation is the record of our membership workers for the past month. If you will note the occupations of these new members you will see that everyone of them is actively engaged in ceramic pursuits and that everyone of them not only needs the backing of the AMERICAN CERAMIC SOCIETY, but is an active, vital ceramic thinker adequate for the enriching of the ceramic world.

You are working an injustice to your friends and acquaintances who would serve and benefit mutually by a membership in this SOCIETY, if you do not invite them. The

following letter from Dr. Silverman of Pittsburgh will show those who have not "gotten into the swing," how new members are obtained. Note that his applicants were men "especially interested in glass." That is what we want: vital members, alive and full of questions and searchings for ceramic facts.

"My Dear Purdy:

I had three Russian visitors this morning who were interested in glass, so I took occasion to enroll them for membership in the American Ceramic Society. Their application cards are inclosed herewith."

Another letter from H. W. Mauser, Jr., of Delft, Holland, illustrates a similar spirit of coöperation.

Koninklijke Delftsch-Aardewerkfabriek "De Porceleyne Fles"

Delft, 16 Nov., 1924

Mr. R. C. Purdy,
Secretary, American Ceramic Society,
Columbus, Ohio.

My Dear Sir:

On re-reading your letter of Sept. 10, including your call for some of our energy for the benefit of the Society and its members, I regretted not being able at the time to write an article for the *Journal*.

Plans there are enough, but not the time to work them out, as we have, happily, an extremely busy time at our factory.

So I came to point two. Perhaps there was an opportunity to do my bit. The August-September list of new members, showing only nine names, showed the necessity of going to deliver a speech to "that friend of mine" you referred to.

So I went over to him. The result you will find enclosed in this letter.

It is a pity Columbus is a little far away for us to come over for a few days only, probably there will come a time, that affairs can be combined, and that I will be able to attend to one of the big "Ceramic Society" Meetings.

Most truly yours,

H. W. Mauser, Jr., *Secretary.*

Speak to that co-worker of yours who is not a member of the Society. He needs the Society and the Society needs him.

NEW MEMBERS RECEIVED FROM DECEMBER 15 to JANUARY 15

PERSONAL

J. O. Benson, Carr-Lowrey Glass Co., Baltimore, Md.

Robert C. Boyd, 700 Center St., Waukegan, Ill. Ceramic Engineer, Chicago Hardware Foundry Co., North Chicago, Ill.

H. L. Brooks, 1658 St. Charles Rd., Cleveland, Ohio, Ferro Enameling Co.

Clarence L. Deeds, Laboratory Asst., Homer-Laughlin China Co., Newell, W. Va.

H. E. Ebright, 1533 Cohassett St., Cleveland, Ohio. Ferro Enameling Co.

Worth S. Elton, Supt., Lyth Tile Corp., Angola, N. Y.

S. Enomoto, Higher Technical School, Tokio, Japan.

Edward C. Greenstreet, Carr-Lowrey Glass Co., Baltimore, Md.

H. J. Ivanowsky, Charkow, Chimougol, Rimarskaia 22, Russia. Chief Engineer, Konstantinowka Glass Works.

W. S. Jacopson, Trust Chimougol, Charkow, Rimarskaia 22, Russia. Managing Director, Lisitshansk Glass Works.

Walter A. King, Laboratory Asst., Pfaudler Co., Elyria, Ohio.

N. F. Krassnikoff, Moscow, Russia, Miasnitzkaia 8. Technical Director, All Russian Silicate Syndicate.

Gordon S. Lindsey, Industrial Fellow, Mellon Institute, Pittsburgh, Pa.

James T. MacKenzie, 4300 Glenwood Ave., Birmingham, Ala., Metallurgist and Chief Chemist, American Cast Iron Pipe Co.

Wilfrid Mavor, 145 Isabella St., Toronto, Canada, Ferro Enameling Co.

Joseph Weir McHugh, 1522 Union St., Schenectady, N. Y. Exptl. Asst., Porcelain Dept., General Electric Co.

Frank L. Michael, 1522 Union St., Schenectady, N. Y. Electrical porcelain, General Electric Co.

Howard S. Orth, 416 Majestic Bldg., Columbus, Ohio. Harrop Tunnel Kilns.

Donald Wolf Randolph, 1106 Church St., Flint, Mich. Research Engineer, A.-C. Spark Plug Co.

W. Leslie Sample, 515 North 9th St., Cambridge, Ohio. Chief (1) Inspector and (2) Research Dept., Cambridge Sanitary Mfg. Co.

Ernest C. Schmatolla, P. O. Box 185, Flint, Mich. Library technologist, A.-C. Spark Plug Co.

Gustav von den Steinen, 2568 Euclid Blvd., Cleveland Heights, Ohio. Vice-president, The Glascote Co., Euclid, Ohio.

Arthur Q. Tool, Physicist, Bur. of Standards, Washington, D. C.

Wolfgang Zöller, Kotzenau Kreis Lüben, Germany. General director of the Iron and Enamel Works, Marienhütte.

CORPORATION

Carl B. Harrop, Engineers and Constructors, 416–19 Majestic Bldg., Columbus, Ohio. C. B. Harrop, Representative.

Membership Workers' Record

	Personal	Corporation		Personal
C. E. Bales	1		S. J. McDowell	2
L. E. Barringer	2		E. P. Poste	1
A. V. Bleininger	1		Frank G. Roberts	1
M. W. Butler	1		A. Silverman	3
J. E. Hansen	1		Bruce F. Wagner	1
C. B. Harrop	1	1	R. A. Weaver	3
R. W. Jones	1		H. G. Wolfram	1
W. Keith McAfee	1		Office	3
			Total	25

PRESENT ADDRESSES UNKNOWN

Note: Kindly notify the Secretary of the Society if you know the correct address of any of the members listed herewith.

All-in-One Plumbing Fixture Corp., 231 Ochsner Bldg., Sacramento, Calif.

Frank Baddeley, 206 E. California St., Walnut Park, Glendale, Calif.

G. V. Baker, Supt. Penna. Feldspar Co., Barnard, N. Y.

Leo T. Butman, F. R. Muller & Co., Waukegan, Ill.

J. P. Callaghan, care of Teaque Hotel, Montgomery, Ala.

T. M. Caven, 564 W. 173d St., New York, N. Y.
August F. Danes, Laclede-Christy Clay Prod. Co., St. Louis, Mo.
Frank M. Didisheim, 234 Union St., Schenectady, N. Y.
Charles S. Dolley, Keramoid Mfg. Co., Fort Madison, Iowa.
S. P. Edson, Bryantville, Mass.
M. S. Gifford, Lake Bluff, Ill.
A. H. Goodman, Box 915, Pittsburgh, Pa.
Fred W. Greenlee, Linerville, Iowa.
John L. Greenwood, Supt., Lehigh Sewer Pipe & Tile Co., Lehigh, Iowa.
C. Knox Harding, 6318 Stony Island Ave., Chicago, Ill.
S. B. Henshaw, Libbey-Owens Sheet Glass, Toledo, Ohio.
Kenneth E. Holley, Alfred, New York.
Edgar Jones, 35 Rimbach Ave., Hammond, Ind.
J. M. Knote, J. M. Gautier & Co., Green & Essex Sts., Jersey City, N. J.
Roy Lacy, 634 S. St. Andrews Pl., Los Angeles, Calif.
Arthur T. Leahy, 5490 Ellis Ave., Chicago, Ill.
Wm. W. Lemmax, Box 59, Taylor, Wash.
Geo. W. Lester, 2176 McClellan Ave., Detroit, Mich.
F. G. Lord, Pa. Pulverizing Co., 341 4th Ave., Pittsburgh, Pa.
Joseph A. Maguire, 440 Martel St., Bethlehem, Pa.
A. T. Meldram, Strathcona Potteries, 99 St. James St., Montreal, Canada.
C. F. Miller, Univ. of Washington, Law School, Seattle, Wash.
F. H. Nies, Cor. Hamilton Ave. & Summit St., Brooklyn, N. Y.
H. M. Pulsifer, Geo. H. Holb & Co., Chicago, Ill.
Paul Q. Quay, Lake Shore Blvd., Euclid, Ohio.
A. E. Saunders, 48 Albermarle Ave., Toronto, Ontario.
A. Lincoln Scott, Auditorium Tower, Chicago, Ill.
Lee Showers, Pittsburgh Plate Glass Co., Pittsburgh, Pa.
Geo. O. Smith, Carr-Lowrey Glass Co., Baltimore, Md.
Clarence A. Stimpson, Chicago Pneumatic Tool Co., Century Bldg., Chicago, Ill.
Chas. H. Stone, Jr., 1210 Oak St., Jacksonville, Fla.
Miss Evelyn Tennyson, Alfred University, Alfred, N. Y.
Erwin F. Theobald, General Delivery, Bessemer, Pa.
Boris Trifonoff, 631 Putnam Ave., Zanesville, Ohio.
Frank A. Weidman, 38 S. Dearborn St., Chicago, Ill.
G. N. White, Sc.D. 7 Victoria Ave., Worcester, England.
E. J. Winkleman, American Refractories Co., Pittsburgh, Pa.
Miles M. Zoller, 208 S. La Salle St., Chicago, Ill.

MEMBERSHIP LIST[1]

P. A. Adams, Mansfield Vitreous Enameling Co., Mansfield, Ohio.—E.
A. O. C. Ahrendts, Atlas China Co., Niles, Ohio.—W. W.
Lewis Albrecht, General Ceramics Co., 50 Church St., New York, N. Y.—H. C. P.
L. R. W. Allison, The Ceramist, Newark, N. J.

[1] This list includes all members of the SOCIETY representing corporation memberships. The initial following the name indicates the Division to which the member belongs, as follows: (A) Art; (E) Enamel; (G) Glass; (H. C. P.), Heavy Clay Products; (R) Refractories; (T. C.), Terra Cotta; (W. W.), White Wares. No initial following the name indicates that the member is unclassified.

[1] ———————, American Terra Cotta & Ceramic Co., 1808 Prairie Ave., Chicago, Ill.—T. C.

Jos. L. Anthony, Glenwood Range Co., Taunton, Mass.—E.

Thos. F. Armstrong, Conkling-Armstrong Terra Cotta Co., Wissahickon & Juniata, Philadelphia, Pa.—T. C.

D. C. Asper, Penn Tile Works Co., Inc., Aspers, Pa.—A.

A. J. Aupperle, American Rolling Mill Co., Middletown, Ohio.—E.

E. B. Ayres, Proctor & Schwartz, Inc., 7th St. & Tabor Rd., Philadelphia, Pa.

Robert Back, The Wahl Co., Chicago, Ill.—R.

George S. Bacon, Whitall-Tatum Co., Millville, N. J.—G.

Frank A. Bailey, DeVilbiss Mfg. Co., Toledo, Ohio.—E.

W. G. Baker, Baker Bros. Glass Co., Okmulgee, Okla.—G.

A. P. Ball, Square D Co., Peru, Ind.—W. W.

George A. Ball, Ball Brothers Co., Muncie, Ind.—G.

Ernest A. Batchelder, Batchelder-Wilson Co., 2633 Artesian St., Los Angeles, Calif.—W. W.

F. W. Beach, Mansfield Sheet & Tin Plate Co., Mansfield, Ohio.—E.

H. L. Beach, Beach Enameling Co., Coshocton, Ohio.—E.

D. A. Benson, Big Savage Fire Brick Co., Frostburg, Md.—R.

C. A. Blackburn, Cleveland Metal Prod. Co., Cleveland, Ohio.—E.

H. H. Blau, Macbeth-Evans Glass Co., Eastern Division, Charleroi, Pa.—G.

C. H. Blumenauer, Jefferson Glass Co., Follansbee, W. Va.—G.

W. E. Bockman, J. A. Bauer Pottery Co., Los Angeles, Calif.—A.

L. H. Bown, Buffalo Pottery, Buffalo, N. Y.—W. W.

W. T. Brangham, Falcon Tin Plate Co., Niles, Ohio.—E.

Chas. Brian, Paper Makers Importing Co., Inc., Easton, Pa.—W. W.

G. S. Bryce, Bryce Bros. Co., Mt. Pleasant, Pa.—G.

A. W. Buckingham, Russell Engineering Co., 1624 Ry. Exchange Bldg., St. Louis, Mo.—R.

J. A. Buckwalter, Buckwalter Stove Co., Royersford, Pa.—E.

J. T. Bunn, U. S. Sanitary Mfg. Co., Monaca, Pa.—E.

S. G. Burt, The Rookwood Pottery Co., Cincinnati, Ohio.—A.

F. W. Butler, Mogadore Insulator Co., Mogadore, Ohio.—W. W.

Louis L. Byers, Abrasive Co., Tacony & Fraley Sts., Philadelphia, Pa.—R.

John A. Campbell, The Trenton Potteries, Trenton, N. J.—W. W.

John H. Cavender, Chicago Retort & Fire Brick Co., 208 S. La Salle St., Chicagco, Ill.—R.

R. L. Cawood, The Patterson Foundry & Machine Co., East Liverpool, Ohio.—W. W.

M. J. Cereghino, Los Angeles Gas & Elec. Corp., Los Angeles, Calif.—R.

G. Oliver Challinor, U. S. Glass Co., S. 9th St., Pittsburgh, Pa.—G.

Thomas Chester, American Blower Co., 6004 Russell St., Detroit, Mich.

H. H. Clark, The Peoples Gas Light & Coke Co., Chicago, Ill.—R.

A. E. Clarke, Benjamin Electric Mfg. Co., Des Plaines, Ill.—E.

Ray Y. Cliff, Saxon China Co., Sebring, Ohio.—W. W.

F. J. Clifford, Chicago Pottery Co., 1924 Clybourn Ave., Chicago, Ill.—W. W.

S. S. Cochrane, Owens Bottle Co., Toledo, Ohio.—G.

L. S. Collins, Los Angeles Brick Co., 514 Security Bldg., Los Angeles, Calif.—H. C. P.

F. R. Corwin, U. S. Metals Refining Co., Carteret, N. J.—R.

---

[1] Company has named no representative.

C. W. Crane, Crossman Co., South Amboy, N. J.—H. C. P.
J. F. Creegan, California Pottery Co., 579 Mills Bldg., San Francisco, Calif.—H. C. P.
D. M. Cronin, Standard Pottery Co., E. Liverpool, Ohio.—W. W.
J. W. Cruikshank, J. W. Cruikshank Eng. Co., Pittsburgh, Pa.—G.
W. E. Cunning, West End Pottery Co., East Liverpool, Ohio,—W. W.
M. F. Cunningham, Waltham Grinding Wheel Co., Waltham, Mass.—R.
R. T. Cunningham, Monongah Glass Co., Fairmont, W. Va.—G.
W. F. Curtis, Fostoria Glass Co., Moundsville, W. Va.—G.

I. F. Dains, Western Stoneware Co., Monmouth, Ill.—W. W.
Richard F. Dalton, New York Architectural Terra Cotta Co., Long Island City, N. Y., —T. C.
A. Davidson, Crown Potteries Co., Evansville, Ind.—W. W.
J. A. De Celle, Chicago Hardware Foundry Co., N. Chicago, Ill.—W. W.
J. M. Dell, Missouri Fire Brick Co., St. Louis, Mo.—R.
W. F. Demuth, The Canton Brick & Fireproofing Co., New Philadelphia, Ohio.—H. C. P.
N. A. Dickey, Livermore Fire Brick Wks., 604 Mission St., San Francisco, Calif.—R.
Geo. W. Dilks, Jr., Seaboard Fuel Corp., 1610 Spruce St., Philadelphia, Pa.
Chas. E. Doll, Mt. Clemens Pottery Co., Mt. Clemens, Mich.—W. W.
H. S. Donaldson, Enterprise White Clay Co., Philadelphia, Pa.—W. W.
B. F. Drakenfeld, Jr., B. F. Drakenfeld & Co., New York City.
B. F. Dunn, Dunn Wire Cut Lug Brick Co., Conneaut, Ohio.—H. C. P.
E. M. Durant, The Pacific Clay Prod., Inc., Los Angeles, Calif.—H. C. P.
Emmet Dwyer, Michigan Stove Co., Detroit, Mich.—E.

T. C. Eayrs, Massillon Stone & Fire Brick Co., Massillon, Ohio.—R.
D. R. Edgar, Edgar Plastic Kaolin Co., Metuchen, N. J.—W. W.
Howard P. Eells, Jr., Dolomite Products Co., Cleveland, Ohio.—R.
C. C. Engle, United Clay Mines Corporation, Trenton, N. J.—W. W.
B. K. Eskesen, Matawan Tile Co., Matawan, N. J.—W. W.
E. V. Eskesen, N. J. Terra Cotta Co., New York City.—T. C.
M. Ezoi, Nippon Gaishi Kwaisha, Atsuta Higashimatch, Nagoya City, Japan.—W. W.

Geo. P. Fackt, Denver Terra Cotta Co., Denver, Colo.—T. C.
Kenneth C. Farnsworth, Roberts & Mander Stove Co., Hatboro, Pa.—E.
[1] ————, Findlay Clay Pot Co., Washington, Pa.—G.
G. F. Fiske, American Stove Co., St. Louis, Mo.—E.
Herbert Forester, Veritas Firing System, Trenton, N. J.—W. W.
Arthur D. Forst, Robertson Art Tile Co., Trenton, N. J.—W. W.
W. H. Foster, National Fireproofing Co., 1126 Fulton Bldg., Pittsburgh, Pa.—R.
C. D. Fraunfelter, Fraunfelter China Co., Zanesville, Ohio.—W. W.
C. E. Frazier, Simplex Engineering Co., Washington, Pa.—G.
[1] ————, Friderichsen Floor & Wall Tile Co., Independence, Mo.—W. W.
[1] ————, Frink Pyrometer Co., Lancaster, Ohio.—G.
E. H. Fritz, Westinghouse High Voltage Insulator Co., Derry, Pa.—W. W.
Howard Frost, Los Angeles Pressed Brick Co., Los Angeles, Calif.—R.
C. E. Fulton, The Pittsburgh Plate Glass Co., Pittsburgh, Pa.—G.

W. I. Gahris, Limoges China Co., Sebring, Ohio.—W. W.
Richard W. Gass, U. S. Smelting Furnace Co., Belleville, Ill.—E.

[1] Company has named no representative.

H. B. Gates, The Armstrong Cork & Insulation Co., Pittsburgh, Pa.—W. W.
M. E. Gates, Clay Service Corp., Chicago, Ill.
W. J. Geddes, Denver Sewer Pipe & Clay Co., Denver, Colo.—H. C. P.
Carl Geist, Geist Mfg. Co., 2001 Atlantic Ave., Atlantic City, N. J.
W. C. George, Canonsburg Pottery Co., Canonsburg, Pa.—W. W.
W. C. George, W. S. George Pottery Co., East Palestine, Ohio.—W. W.
Jas. Gillinder, Gillinder Bros., Port Jervis, N. Y.—G.
A. Goetz, Jointless Fire Brick Co., 1130 Clay St., Chicago, Ill.—R.
Chas. E. Golding, Golding-Keene Co., Keene, N. H.—W. W.
Sigmund Goldman, English China Clays Sales Corp., 33 W. 42nd St., New York, N. Y.—W. W.
Werner H. Grabbe, Columbian Enameling & Stamping Co., Terre Haute, Ind.—E.
R. F. Grady, St. Louis Terra Cotta Co., St. Louis, Mo.—T. C.
C. O. Grafton, Gill Clay Pot Co., Muncie, Ind.—G.
E. H. Graham, Washington Iron Works, Los Angeles, Calif.—E.
De Forest Grant, Federal Terra Cotta Co., New York City.—T. C.
J. L. Green, Laclede-Christy Clay Products Co., St. Louis, Mo.—R.

E. H. Haeger, The Haeger Potteries, Inc., Dundee, Ill.—W. W.
J. W. Hall, The Westport Paving Brick Co., Baltimore, Md.—H. C. P.
Lee Hall, Federal Electric Co., 8700 S. State St., Chicago, Ill.
W. L. Hanley, Jr., Bradford Brick & Tile Co., Bradford, Pa.—H. C. P.
Abel Hansen, Fords Porcelain Works, Perth Amboy, N. J.—W. W.
E. O. Harbeck, Challenge Refrigerator Co., Grand Haven, Mich.
Harlowe Hardinge, Hardinge Co., Inc., York, Pa.
Carl B. Harrop, C. B. Harrop Co., 416 Majestic Bldg., Columbus, Ohio.—H. C. P.
W. A. Harshaw, Harshaw Fuller & Goodwin Co., 545 Hanna Bldg., Cleveland, Ohio.
Isaac Harter, Babcock & Wilcox Co., 85 Liberty St., New York, N. Y.—R.
Hamilton Hazelhurst, Old Bridge Enameled Brick & Tile Co., Old Bridge, N. J.—W. W.
Jos. Heidenkamp, Heidenkamp Plate Glass Co., Springdale, Pa.—G.
A. C. Held, Rundle Mfg. Co., Milwaukee, Wis.—E.
F. R. Henry, The A. A. Simonds-Dayton Co., Dayton, Ohio.—R.
W. H. Herbert, W. G. Bush & Co., 174 Third Ave., N., Nashville, Tenn.—H. C. P.
R. P. Herrold, Mosaic Tile Co., Zanesville, Ohio.—W. W.
R. F. Hess, Crescent Refractories Co., Curwensville, Pa.—R.
James H. Hill, Alberhill Coal & Clay Co., Alberhill, Calif.—H. C. P.
W. B. Hitchcock, Portsmouth Refractories Co., Portsmouth, Ohio.—R.
E. F. Hoerger, Canton Stamping & Enameling Co., Canton, Ohio.—E.
A. A. Holmes, American Trona Corp., 233 Broadway, New York, N. Y.—A.
Lee Holtz, So. California Gas Co., 950 Broadway, Los Angeles, Calif.
W. F. Hosford, Western Electric Co., Hawthorne Sta., Chicago, Ill.—W. W.
A. F. Hottinger, Chicago Crucible Co., 2525 Clybourn Ave., Chicago, Ill.—R.
A. F. Hottinger, Northwestern Terra Cotta Co., Chicago, Ill.—T. C.
Roger J. Houze, L. J. Houze Convex Glass Co., Point Marion, Pa.—G.
R. D. Humphreys, Mississippi Glass Co., 220 Fifth Ave., New York, N. Y.—G.
C. E. Husted, Edward Ford Plate Glass, Rossford, Ohio.—G.

Charles Ingram, Clinchfield Products Corp., 350 Madison Ave., New York, N. Y.—W. W.
[1] ————, Iron City Sanitary Mfg. Co., Pittsburgh, Pa.—E.

[1] Company has named no representative.

D. C. Irwin, Potters Supply Co., East Liverpool, Ohio.—W. W.
M. Ise, Nippon Toki Kwaisha Noritake, Nagoya City, Japan.—W. W.

C. E. Jackson, Warwick China Co., Wheeling, W. Va.—W. W.
H. S. Jacoby, H. K. Ferguson Co., 6523 Euclid Ave., Cleveland, Ohio.
J. F. Jeffery, The Champion Porcelain Co., Detroit, Mich.—W. W.

G. C. Kalbfleisch, Standard Sanitary Mfg. Co., Tiffin, Ohio.—W. W.
B. C. Keeler, Mason City Brick & Tile Co., Mason City, Iowa.—H. C. P.
R. B. Keplinger, Metropolitan Paving Brick Co., Canton, Ohio.—H. C. P.
O. W. Ketcham, O. W. Ketcham Co., 125 N. 18th St., Philadelphia, Pa.—T. C.
P. S. Kier, Kier Fire Brick Co., Pittsburgh, Pa.
C. J. Kirk, Universal Sanitary Mfg. Co., New Castle, Pa.—W. W.
H. F. Kleinfeldt, Abbe Engineering Co., 50 Church St., New York, N. Y.
Frank P. Knight, Mineral Products Co., 50 Congress St., Boston, Mass.—W. W.
W. F. Knoesel, Mitchell Clay Mfg. Co., 5627 Manchester Ave., St. Louis, Mo.—R.
Walter J. Kohler, Kohler Company, Kohler, Wis.—E.
John B. Krauss, Portsmouth Stove & Range Co., Portsmouth, Ohio.—E.
John Kruesi, American Lava Corp., Chattanooga, Tenn.—W. W.
John C. Kurtz, Bausch & Lomb Optical Co., Rochester, N. Y.—G.

H. S. Langworthy, Jewettville Clay Products Co., Jewettville, N. Y.—H. C. P.
G. W. Lapp, Lapp Insulator Co., Inc., Leroy, N. Y.—W. W.
S. B. Larkins, The National China Co., Salineville, Ohio.—W. W.
W. H. Lentz, U. S. Gauge Co., Sellersville, Pa.
Chas. H. Leonard, Grand Rapids Refrigerator Co., Grand Rapids, Mich.—E.
H. D. Lillibridge, American Encaustic Tiling Co., Zanesville, Ohio.—W. W.
W. C. Lindemann, A. J. Lindemann & Hoverson Co., Milwaukee, Wis.—E.
H. B. Little, Baltimore Enamel & Novelty, Baltimore, Md.—E.
D. W. Loomis, H. L. Dixon Co., Box 140, Pittsburgh, Pa.—G.
W. B. Louthan, Louthan Mfg. Co., East Liverpool, Ohio.—W. W.

Atholl McBean, Gladding, McBean & Co., San Francisco, Calif.—T. C.
F. R. McCannell, Milton Pressed Brick Co., Milton, Ont., Canada.—H. C. P.
[1] ————, McLain Fire Brick Co., Wellsville, Ohio.—R.
T. A. McDonald, Coonley Mfg. Co., Cicero, Ill.—E.
Taine G. McDougal, A-C Spark Plug Co., Flint, Mich.—W. W.
[1] ————, McLanahan-Watkins Co., Charlotte Court House, Va.—R.
D. E. McNicol, D. E. McNicol Pottery Co., East Liverpool, Ohio.—W. W.
P. S. MacMichael, Northern Clay Co., Auburn, Wash.—T. C.
C. S. Maddock, Jr., Thomas Maddock's Sons Co., Trenton, N. J.—W. W.
Frank B. Mahoney, Humphryes Mfg. Co., Mansfield, Ohio.—E.
A. T. Malm, Norton Co., Worcester, Mass.—R.
Werner Malsch, Roessler & Hasslacher Chemical Co., New York City.—W. W.
R. A. Manegold, Dings Magnetic Separator Co., Milwaukee, Wis.—E.
Thos. S. Mann, Pacific Stoneware Co., Portland, Ore.—W. W.
J. M. Manor, Golding Sons Co., East Liverpool, Ohio.—W. W.
H. B. Manton, Robinson Clay Products Co., 1100 Second Natl. Bldg., Akron, Ohio.—H. C. P.

[1] Company has named no representative.

Jas. P. Martin, Lancaster Iron Works, Inc., Lancaster, Pa.—H. C. P.
John D. Martin, Straitsville Impervious Brick Co., New Straitsville, Ohio.—H. C. P.
L. H. Maxfield, Illinois Glass Co., Alton, Ill.—G.
W. H. Mead, Whiting-Mead Commercial Co., Los Angeles, Calif.—E.
M. B. Meanley, Jones Hollow Ware Co., Baltimore, Md.—E.
L. D. Mercer, United Alloy Steel Corp., Canton, Ohio.—E.
D. M. Miller, Crossley Machine Co., Trenton, N. J.
G. C. Mitchell, Pope-Gosser China Co., Coshocton, Ohio.—W. W.
S. Momoki, Toyo Toko Kwaisha Shinozaki, Kokura City, Japan.—W. W.
E. T. Montgomery, Montgomery Porcelain Products Co., Franklin, Ohio.—W. W.
[1] ————, Moore & Munger, New York City.—W. W.
S. I. Morley, Crescent China Co., Alliance, Ohio.—W. W.
L. A. Morris, Florida China Clay Co., Box 83, Leesburg, Florida.—W. W.
H. C. Mueller, Mueller Mosaic Co., Trenton, N. J.—W. W.
L. A. Munro, Brunner Mond & Co., Ltd., Northwich, England.—W. W.

J. H. M. Nash, Hazel-Atlas Glass Co., Wheeling, W. Va.—G.
[1] ————, National Lime Association, Washington, D. C.
R. N. Newcomb, Charles Engelhard, Inc., 30 Church St., New York, N. Y.—W. W.
F. P. Nickerson, The W. S. Tyler Co., Cleveland, Ohio.
[1] ————, N. C. Geological & Economic Survey, Raleigh, N. C.

P. C. Olsen, South Amboy Terra Cotta Co., New York City.—T. C.
F. B. Ortman, Tropico Potteries, Inc., Glendale, Calif.—T. C.
Edward Orton, Jr., Standard Pyrometric Cone Co., Columbus, Ohio.

Thos. W. Pangborn, Pangborn Corporation, Hagerstown, Md.—E.
G. W. Parker, Parker-Russell Mining & Mfg. Co., St. Louis, Mo.—R.
Henry T. Parst, Electric Porcelain & Mfg. Co., Trenton, N. J.—W. W.
[1] ————, Pennsylvania Salt Mfg. Co., Pittsburgh, Pa.
R. O. Perrott, Hadfield-Penfield Steel Co., Bucyrus, Ohio.—R.
[1] ————, The Pfaudler Co., Rochester, N. Y.—E.
G. Q. Phillips, Olean Tile Co., Olean, N. Y.—W.
W. H. Phillips, Smith-Phillips China Co., East Liverpool, Ohio.—W. W.
E. Bertram Pike, Cortland Grinding Wheels Corp., Chester, Mass.—R.
F. G. Porter, Globe Brick Co., Box 765, E. Liverpool, Ohio.—H. C. P.
A. C. Postley, River Feldspar & Milling Co., Middletown, Conn.—W. W.
H. W. Powell, Crane Enamelware Co., Chattanooga, Tenn.—E.
W. H. Powell, Atlantic Terra Cotta Co., 350 Madison Ave., New York City.—T. C.
F. C. Preston, Dover Fire Brick Co., Cleveland, Ohio.—R.
W. S. Primley, Midland Terra Cotta Co., Chicago, Ill.—T. C.
B. S. Purinton, East Liverpool Potteries Co., Wellsville, Ohio.—W. W.

C. H. Rasmussen, Perth Amboy Tile Co., Perth Amboy, N. J.—W. W.
[1] ————, Reading Fire Brick Works, Reading, Pa.—R.
F. H. Reagan, Locke Insulator Co., Baltimore, Md.—W. W.
Ernest Richardson, Ingram-Richardson Mfg. Co., Beaver Falls, Pa.—E.
E. A. Richardson, The Libbey Glass Mfg. Co., Toledo, Ohio.—G.
W. Riehl, Hanovia Chemical & Mfg. Co., Chestnut St. & N. J. R. R. Ave., Newark, N. J.

[1] Company has named no representative.

Dewitt F. Riess, The Vollrath Co., Sheboygan, Wis.—E.
John T. Roberts, Stockton Fire Brick Co., 915 Rialto Bldg., San Francisco, Calif.—R.
F. E. Robinson, Garfield Fire Clay Co., Robinson, Ind. Co., Pa.—R.
Wm. H. Robinson, The Colonial Co., E. Liverpool, Ohio.—W. W.
J. Rodgers, The Product Sales Co., Baltimore, Md.
Otto Rosenstein, Illinois-Pacific Glass Co., 15th & Folsom Sts., San Francisco, Calif.—G.

B. E. Salisbury, Pass & Seymour, Inc., Solvay, N. Y.—W. W.
B. E. Salisbury, The Onondaga Pottery Co., Syracuse, N. Y.—W. W.
T. H. Sant, The John Sant & Sons Co., East Liverpool, Ohio.—W. W.
[1] ————, Scranton Enameling Co., Scranton, Pa.—E.
J. M. Seasholtz, J. M. Seasholtz Co., Reading, Pa.—E.
Kenneth Seaver, Harbison-Walker Refractories Co., Pittsburgh, Pa.—R.
C. L. Sebring, The Sebring Pottery Co., Sebring, Ohio.—W. W.
F. H. Sebring, Salem China Co., Salem, Ohio.—W. W.
J. F. Sheehy, Alhambra Tile Co., Newport, Ky.—E.
Jos. M. Sherburne, Lindsay Light Co., 161 E. Grand Ave., Chicago, Ill.—E.
Alvin G. Sherman, Detroit Vapor Stove Co., Detroit, Mich.—E.
Geo. Shoemaker, The Clay Products Co., Brazil, Ind.—H. C. P.
Herbert Sinclair, Star Porcelain Co., Trenton, N. J.—W. W.
Geo. H. Slater, Carr-Lowrey Glass Co., Baltimore, Md.—G.
J. F. Sinclair, Jeffery-Dewitt Ins. Co., Kenova, W. Va.—W. W.
F. Goodwin Smith, Hartford-Empire Co., Hartford, Conn.—G.
H. P. Smith, Joseph Dixon Crucible Co., Jersey City, N. J.—R.
N. G. Smith, Maine Feldspar Co., Auburn, Maine.—W. W.
W. H. Smith, Canadain General Electric Co., Ltd., Peterborough, Canada.—W. W.
W. L. Smith, Jr., Taylor, Smith & Taylor Co., Chester, W. Va.—W. W.
H. F. Spier, N. J. Pulverizing Co., New York City.—W. W.
H. F. Staley, Metal & Thermit Corp., New York City.—E.
W. S. Stapler, Stevens, Inc., 101 Marietta St., Atlanta, Ga.—R.
[1] ————, Stettiner Chamottefabrik, Akt.-Ges. vorm Didier, Stettin, Schwarzer, Damm lu 13 a, Germany.
Douglas F. Stevens, Acme Brick Co., 412 Adams Bldg., Danville, Ill.—H. C. P.
A. H. Stewart, Phoenix Glass Co., Pittsburgh, Pa.—G.
T. A. Stoelzle, Karr Range Co., Belleville, Ill.—E.
E. C. Sullivan, Corning Glass Works, Corning, N. Y.—G.
R. A. Swam, Denny-Renton Clay & Coal Co., Seattle, Wash.—T. C.

David S. Taylor, H. D. Pochin & Co., Ltd., Worsley St., Manchester, England.—W. W.
Homer J. Taylor, Knowles, Taylor & Knowles Co., E. Liverpool, Ohio.—W. W.
G. R. Thomas, R. Thomas & Sons Co., East Liverpool, Ohio.—W. W.
J. B. Thomas, Electro-Alloys Co., Taylor St., Elyria, Ohio.—E.
Andrew Thompson, Titanium Alloy Mfg. Co., Niagara Falls, N. Y.—E.
M. W. Thompson, Hall China Co., E. Liverpool, Ohio.—W. W.
Frank W. Thropp, Eureka Flint & Spar Co., Trenton, N. J.—W. W.
C. H. Tiebout, Jr., Gleason-Tiebout Glass Co., Brooklyn, N. Y.—G.
F. J. Tone, Carborundum Co., Niagara Falls, N. Y.—R.
Karl Turk, Porcelain Enamel & Mfg. Co., Baltimore, Md.—E.
Lance Turnbull, Johnson Porter Clay Co., McKenzie, Tenn.—W. W.
Jas. Turner, Cook China Co., Trenton, N. J.—W. W.

[1] Company has named no representative.

R. T. Vanderbilt, R. T. Vanderbilt Co., 50 E. 42nd St., New York, N. Y.—W. W.
[1]———, Vitrefrax Co., Los Angeles, Calif.—R.
Josef Vollkommer, Vitro Mfg. Co., Pittsburgh, Pa.—E.
W. J. Vollrath, Polar Ware Co., Sheboygan, Wis.—E.

F. W. Walker, Associated Tile Mfrs., Beaver Falls, Pa.—W. W.
F. W. Walker, Jr., Beaver Falls Art Tile Co., Beaver Falls, Pa.—W. W.
Harry Watkin, Edwin M. Knowles China Co., Newell, W. Va.—W. W.
August Weber, Jr., Weber Electric Co., Schenectady, N. Y.—W. W.
W. W. Wehrle, The Wehrle Co., Newark, Ohio.—E.
Edgar H. Weil, Vitreous Enameling Co., Cleveland, Ohio.—E.
W. E. Wells, Homer-Laughlin China Co., E. Liverpool, Ohio.—W. W.
Frank H. Whelden, Detroit Star Grinding Wheel Co., 111 Cavalry Ave., Detroit, Mich. —R.
W. B. Whitney, Springfield Paving Brick Co., Box 403, Springfield, Ill.—H. C. P.
C. W. Williams, Electrical Refractories Co., E. Clark St., E. Palestine, Ohio.—R.
J. A. Williams, Mitchell-Bissell Co., New York City.—W. W.
[1]———, Wolverine Porcelain Co., Detroit, Mich.—E.
Wm. J. Woods, Pennsylvania Pulverizing Co., Lewistown, Pa.—W. W.
A. P. Woolfolk, Standard Sanitary Mfg. Co., Pittsburgh, Pa.—E.

R. T. Young, The Roseville Pottery Co., Zanesville, Ohio.—A.

A. S. Zopfi, Buckeye Clay Pot Co., Toledo, Ohio.—G.
E. G. Zorn, Industrial Publications, Inc., 407 S. Dearborn St., Chicago, Ill.—H. C. P.

PERSONAL NOTES

Howard C. Arnold has become affiliated lately with the Tiffany Enameled Brick Company of Momence, Illinois, Box 323.

Alice A. Ayars has returned to the New Amsterdam Hotel, Cleveland, Ohio, from Coconut Grove, Fla., where she has been visiting her parents and her brother, E. E. Ayars.

Harold D. Barger, formerly salesman for the Wellsville Fire Brick Co., Wellsville, Mo., is living at 1927 E. 71st St., Cleveland, Ohio.

Richard S. Bradley has moved from Mexico, Mo., to Bement, Illinois.

Emil Bronland, lately of Seattle, Wash., is now in Schumacher, Ont., Canada.

O. I. Chorman, of the Pfaudler Co., has been transferred from Rochester to Niagara Falls, N. Y.

W. W. Coates, Jr., announces his removal from Carrs Station, Ga., where he was affiliated with the Dixie Fireproofing Co., Macon, Ga., to 2810 Tracy Ave., Kansas City. He is now associated with the Coats Mfg. Co.

Julian Corman, of Murphysboro, Ill., is at present at 6016 Bartmer St., St. Louis, Mo.

George B. Cunning is now living at 309 W. Fourth St., East Liverpool, Ohio, having recently moved from New Lexington.

R. L. Frink who has been Director of Research, Glass Research Association, London, England, has accepted a position with the South Manchurian Railway Co., and is located at Darien, Manchuria.

C. C. Hayward, of the General Refractories Company, has been transferred from St. Louis, Mo., to Detroit, Mich.

[1] Company has named no representative.

I. A. Krusen, who was located at the Bureau of Mines, Columbus, Ohio, has accepted a position as General Manager of the Crescent Brick Co., Empire Bldg., Pittsburgh, Pa.

Frank E. Layman, formerly of Toronto, Can., has removed to 95 Harrison Street, East Orange, N. J.

Kai-Ching Lu, student member of the SOCIETY, has moved from Urbana, Ill., to 181 W. 10th Ave., Columbus, Ohio.

Frobisher T. Lyttle, of Scarsdale, N. Y., recently located at Whiting, Ind.

Hyman S. Magid has moved from Tiffin, Ohio, to Kokomo, Ind.

G. Z. Minton, of the Pittsburgh Plate Glass Co., has removed from Elwood, Ind., to the Crystal City, Mo. plant of the same Company.

G. V. Nightingale, recently of the Celite Products Co., Philadelphia, has resigned his position with this Company and is now associated as Sales Engineer with the Republic Flow Meters Co., of Chicago, in their Philadelphia office.

Clifford H. Parmelee, of the Onondaga Pottery Co., has moved from Warners, N. Y., to Syracuse.

E. E. Pressler is now affiliated with the U. S. Bureau of Standards, Washington, D. C.

Wm. A. Rhodes, formerly of the Albert Pick & Co., Chicago, Ill., is now associated with the Jackson Vitrified China Company, Jefferson County, Falls Creek, Pa.

Royal W. Taylor has removed from Canton, Ohio, to 611 S. Lawn Ave., Coshocton, Ohio.

C. Forrest Tefft, who has been connected with Fiske & Co., Inc., for the past ten years as ceramic engineer, plant manager and finally factory manager in charge of all plants, has left the services of this Company to enter into Ceramic Consulting Engineering with headquarters at Watsontown, Pa.

Edward J. Vachuska, former student at Alfred Univ., is now connected with Rutgers College, New Brunswick, N. J.

N. S. C. Walsh has moved from New York City to 4070 N. Main St., St. Louis, Mo.

The Weir Stove Company, of Taunton, Mass., has announced a change in the firm name and is now known as **The Glenwood Range Company.**

C. B. Young has moved from Columbus, Ohio, to New Lexington, Ohio.

THE ENAMEL DIVISION COÖPERATIVE RESEARCH

Manufacturers of enameled cast iron wares are coming to realize more and more that a large proportion of their imperfect wares is due to defective or unsuitable iron. This is true, not only with regard to chipping and crazing caused by unsuspected changes in the contraction of the iron, but more particularly with regard to the formation of pimples and blisters in the enamel. There is little doubt that every enameler of cast iron in the country, whether he makes sanitary wares, stove parts, or specialties, suffers a loss of thousands of dollars each year from the development of these pestiferous and seemingly inexplicable blisters.

Some preliminary research has been done on this subject, but the problem is so large and so intricate that it can never be adequately studied or solved by the individual research men and technical men in the industry. It requires the use of an experimental foundry and the coöperation of these practical enamelers and foundrymen with a group of highly trained metallurgists, metallographers, chemists, and physicists. Therefore, the Committee on Research of the Enamel Division of the AMERICAN CERAMIC SOCIETY has been exceedingly fortunate in securing the active coöperation of several depart-

ments of the U. S. Bureau of Standards in a thorough investigation of the relations between the composition and structure of cast irons and their enameling properties.

The Bureau will make a large number of melts of cast iron in its experimental cupola; will make test bars of each heat; will determine the physical properties of these test bars; will make enameling tests of castings from each heat; will make chemical analyses of each heat; and conduct metallographic studies of the iron of each heat before and after enameling. The tentative program as outlined will mean that active work will be conducted by the Bureau on this problem for at least one year and the cost to the Bureau will be somewhere between five and ten thousand dollars annually. The only requirement it makes of the Enamel Division of the AMERICAN CERAMIC SOCIETY is that the Division furnish the pig iron and coke used in making the various melts, and co-operate in making the enameling tests. Later the Bureau will ask for practical shop tests of its findings.

While the amount of money to be spent by the Enamel Division is very small in comparison with that to be expended by the Bureau, it will amount to a considerable sum, possibly a thousand dollars. To raise this fund, the Division has established a Cast Iron Research Fund, and is asking every firm enameling cast iron in this country, and others indirectly interested in the development of the industry, to contribute $50.00 each to the fund. The Division pledges its word that every cent contributed will be spent for research in the enameling of cast iron. Each contributor will be listed in the records of the Division as a "Research Patron" of the Enamel Division for the year 1925.

Due to the generous contributions of material by one stove manufacturer and one sanitary ware manufacturer, and to pledging of funds by individual members of the Committee, this investigation is now under way at the Bureau of Standards. If you are interested in reducing your enameling losses, and at the same time in taking your part in a movement for the welfare of the whole industry, please send us a check.

COMMITTEE ON RESEARCH,

Homer F. Staley, Metal & Thermit Corp., *Chairman*
E. P. Poste, Pfaudler Co., Elyria, Ohio, *Treasurer*
W. C. Lindemann, A. J. Lindemann & Hoverson Co.
M. E. Manson, Rundle Manufacturing Co.
L. G. Wassman, Wolff Manufacturing Co.

Kindly mark check "Cast Iron Research Fund," make it payable to E. P. Poste, and send it to Mr. Poste, care of The Pfaudler Co., Elyria, Ohio.

BALTIMORE-WASHINGTON SECTION MEETING, JANUARY 3, 1925[1]

The second meeting of the season of the Baltimore-Washington Section was held at the Lee House, Washington, D. C., on Saturday, January 3, at 7:00 P.M. As usual an informal dinner preceded the business of the meeting.

A paper was delivered by A. N. Finn, of the Glass Division of the Bureau of Standards on "Work of the Glass Division of the Bureau of Standards."

There was adopted a set time for meetings to be held in the future. These meetings to be held the first Saturday in each of the following months, February, April, October and December. The meetings are to alternate between the two cities.

[1] R. FUSSELBAUGH, Secretary-Treasurer, Baltimore-Washington Section.

PACIFIC NORTHWEST CLAY WORKERS' ASSN. AND PACIFIC NORTHWEST BRICK MFGRS.' ASSN.

The members of the Pacific Northwest Clay Workers' Assn. and Pacific Northwest Brick Manufacturers' Assn., held an interesting meeting Saturday, January 17, 1925, at Seattle. A banquet was served in the evening at the Olympic Hotel. The program consisted of papers presented by the following members.

"Clays and Shales of Puget Sound Region," by T. O. Smith, Univ. of Wash. "Discussion of Scumming of Brickwork," by M. E. Reynolds, Univ. of Wash. "Marketing Clay Products," W. A. Russell, Professor in College of Business Administration, Univ. of Wash. "The Insulation of Ceramic Kilns," by E. J. Bartells, Clay Products Delivery Co., Seattle. "Spalling Tests of Local Fire Brick," by Hewitt Wilson, Univ. of Wash.

CALIFORNIA SECTION MEETING

The California local section of the American Ceramic Society held a meeting in December at which time the following officers were elected: *President,* T. S. Curtis, of the Vitrefrax Co.; *Vice-President,* Robert Linton, Pacific Clay Products Company; *Treasurer,* H. A. Huisken, Vitrefrax Company; *Secretary,* Harry Davis, Tropico Potteries.

NEW JERSEY CLAY WORKERS IN ANNUAL MEETING

The Annual Meeting of the New Jersey Clay Workers Assn. and Eastern Section of the American Ceramic Society was held in the Assembly Room, Ceramics Building, Rutgers College, New Brunswick, N. J., on Dec. 19, 1924. The programs for the morning and afternoon sessions were as follows.

Morning Session

Business Session.

Presidential Address—Charles W. Crane, Crossman Co., South Amboy, N. J.

"Factory Tests for Feldspar"—John M. Kreger, Woodbridge Ceramic Corporation, Woodbridge, N. J.

"Requisite Qualities of Glazed Wall Tile for Exterior Purposes"—G. H. Brown, Department of Ceramics, Rutgers College, New Brunswick, N. J.

Installation of new officers.

Afternoon Session

"Some Recent Developments in the Utilization of Casting Scrap in Casting Slips"—E. A. Slagle and Andrew Foltz, Lambertville, N. J.

"Zircon As a Constituent of Ceramic Bodies"—W. L. Shearer, Department of Ceramics, Rutgers College, New Brunswick, N. J.

"A Rapid Fire Tunnel Kiln for Smaller Wares"—Taine G. McDougal, A.-C. Spark Plug Co., Flint, Michigan.

"Oil-Firing as Applied to Ceramics"—L. A. Mekler, Combustion Engineer, Chicago Illinois.

William P. Blair.

NOTES AND NEWS

OBITUARY

Wm. P. Blair, Vice-President of the National Paving Brick Manufacturers' Association

William P. Blair, Active Vice-President of the National Paving Brick Manufacturers' Association, died at his home, 1859 Page Avenue, East Cleveland, Ohio, Tuesday morning, December 23, 1924, at 8:30 o'clock. Mr. Blair was founder and organizer of the National Paving Brick Manufacturers' Association, now nearly a quarter of a century old and his loss will be deeply felt not only by his family and close friends but by hundreds of men in the heavy clay products industry.

Mr. Blair was born at Plainfield, Ind., in 1848. He was educated at Earlham College, Richmond, Ind. In his early manhood he practiced law and was a member of the bar in Indiana. He also taught school and was interested in the lumber business.

He is survived by a widow, Viola, a son, Marion, o East St. Louis, Ill., and a daughter, Miss Jessie Blair, residing at home. He has been a resident of Cleveland for fifteen years.

Mr. Blair's interests and activities were concerned with the manufacture of paving brick. He became interested in the Good Roads Movement and was a pioneer in scientific research particularly that branch dealing with the character of sub-soils and their bearing power. Mr. Blair was one of the first of the Nation's Highway Engineers to realize that adequate drainage should be one of the prime considerations in the design and construction of the pavement structure.

As a member of the following organizations, Mr. Blair was exceedingly active:

Cleveland Chamber of Commerce, and a Councillor from the Cleveland Chamber to U. S. Chamber of Commerce
Cleveland Engineering Society
Civic League of Cleveland
Cleveland City Club
Cleveland Automobile Club
Cleveland Chapter, American Association of Engineers (Past President)
Trustee of the Ohio Federation of Good Roads
Member of the International Road Congress
Director of the American Road Builders' Association
Member American Society for Testing Materials
Member American Society for Municipal Improvements
Member of the following State Engineering Societies: Ohio, Illinois, Indiana, Wisconsin, Michigan, Iowa.

Mr. Blair was always active in helping to secure Federal Aid Legislation through the American Congress and left a sick bed to make a trip to Washington, D. C., to attend a meeting of the Highway Research Council. Upon his return to Cleveland he immediately le t for Columbus, Ohio, to attend a meeting of the Ohio Good Roads Federation. He persistently refused to lighten his efforts at the oft repeated request of relatives, friends and business associates. Mr. Blair just as repeatedly insisted that the promotion of the proper design and construction of all pavements and particularly vitrified brick pavement was his absorbing interest in life.

His acquaintanceship was unusually wide in the United States, and spread to England and the Continent of Europe where he numbered many friends among those interested in highway development.

RESEARCH GRADUATE ASSISTANTSHIPS

Engineering Experiment Station, University of Illinois

To assist in the conduct of engineering research and to extend and strengthen the field of its graduate work in engineering, the University of Illinois maintains fourteen Research Graduate Assistantships in the Engineering Experiment Station. Two other such assistantships have been established under the patronage of the Illinois Gas Association. These assistantships, for each of which there is an annual stipend of $600 and freedom from all fees except the matriculation and diploma fees, are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics, or applied chemistry.

An appointment to the position of Research Graduate Assistant is made and must be accepted for two consecutive collegiate years of ten months each, at the expiration of which period, if all requirements have been met, the degree of Master of Science will be conferred. Half of the time of a Research Graduate Assistant (approximately 900 clock hours for each ten-month period) is required in connection with the work of the department to which he is assigned, the remainder being available for graduate study.

Nominations to these positions, accompanied by assignments to special departments of the Engineering Experiment Station, are made from applications received by the Director of the Station each year not later than the first day of April. The nominations are made by the Executive Staff of the Station, subject to the approval of the President of the University. Nominations are based upon the character, scholastic attainments, and promise of success in the principal line of study or research to which the candidate proposes to devote himself. Preference is given those applicants who have had some practical engineering experience following the completion of their undergraduate work. Appointments are made in the spring, and they become effective the first day of the following September. Vacancies may be filled by similar nominations and appointments at other times.

The Engineering Experiment Station, an organization within the College of Engineering, was established in 1903 for the purpose of conducting investigations in the various branches of engineering, and for the study of problems of importance to engineers and to the manufacturing and industrial interests of the State of Illinois. Research work and graduate study may be undertaken in architecture, architectural engineering, ceramic engineering, chemistry, civil engineering, electrical engineering, mechanical engineering, mining engineering, municipal and sanitary engineering, physics, railway engineering, and theoretical and applied mechanics.

The work of the Engineering Experiment Station is closely related to that of the College of Engineering, and the Heads of Departments in the College constitute the Executive Staff of the Station. Investigations are carried on by members of the Station staff and also by members of the instructional staff of the College of Engineering.

Additional information may be obtained by addressing

THE DIRECTOR
Engineering Experiment Station,
University of Illinois, Urbana, Ill.

PUBLICATIONS RELATING TO CERAMICS—BUREAU OF STANDARDS[1]

Scientific Papers

Number	Title	Price
*S 212	Melting Points of Some Refractory Oxides	
S 358	Concerning the Annealing and Characteristics of Glass	$0.10
S 373	Characteristics of Striae in Optical Glass	.05
S 393	Measurements of Thermal Dilatation of Glass at High Temperatures	.10

Technologic Papers

Number	Title	Price
T 1	Effect of Preliminary Heat Treatment upon the Drying of Clays	.10
*T 7	The Testing of Clay Refractories, with Special Reference to their Load-Carrying Ability at Furnace Temperatures	
T 10	The Melting Point of Fire Brick	.05
*T 17	The Function of Time in the Vitrification of Clays	
T 21	The Dehydration of Clays	.05
*T 22	The Effect of Overfiring upon the Structure of Clays	
*T 23	The Technical Control of the Colloidal Matter of Clays	
*T 30	Viscosity of Porcelain Bodies	
*T 31	Some Leadless Boro-Silicate Glazes Maturing at about 1100°C	
T 40	The Veritas Firing Rings	.05
*T 46	A Study of the Atterberg Plasticity Method	
T 50	The Viscosity of Porcelain Bodies High in Feldspar	.05
*T 51	Use of Sodium Salts in the Purification of Clays and in the Casting Process	
T 79	Properties of Some European Plastic Fire Clays	.10
T 80	Constitution and Microstructure of Porcelain	.25
T 85	Manufacture and Properties of Sand-Lime Brick	.10
T 104	The Effect of Size of Grog in Fire Clay Bodies	.10
T 105	Comparative Tests of Porcelain Laboratory Ware	.05
T 107	Comparative Tests of Chemical Glassware	.10
T 111	The Compressive Strength of Large Brick Piers	.10
T 116	Silica Refractories—Factors Affecting Their Quality and Methods of Testing the Raw Materials and Finished Ware	.20
T 120	Tests of Hollow Building Tile	.05
T 124	Constitution and Microstructure of Silica Brick and Changes Involved through Repeated Burnings at High Temperatures	.10
T 142	Materials and Methods Used in the Manufacture of Enameled Cast-Iron Wares	.20
T 144	The Properties of American Bond Clays and Their Use in Graphite Crucibles and Glass Pots	.10
T 155	Cements for Spark Plug Electrodes	.05
T 159	Porosity and Volume Changes of Clay Fire Bricks at Furnace Temperatures	.05
T 165	Enamels for Sheet Iron and Steel	.15

[1] The publications not starred may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., at the prices stated. Those marked with a star are out of print, but may be consulted at leading libraries.

Number	Title	Price
T 196	High-Fire Porcelain Glazes	.05
T 227	American and English Ball Clays	.10
T 234	Methods of Measuring the Plasticity of Clays	.10
T 246	Wet-Process Enamels for Cast Iron	.10
T 262	Comparison of American and Foreign Clays as Paper Fillers	.15

Circulars

Number	Title	Price
C 119	Specifications for Lime-Flint Glass Tumblers	.05
C 164	U. S. Government Master Specification for Flat Glass for Glazing Purposes	.05

Specifications Issued by Federal Specifications Board

Copies can be obtained free of charge from the Chairman, Federal Specifications Board, Bureau of Standards, Washington, D. C.

Specification 243. U. S. Government Master Specification for Vitrified Chinaware.

Publications Appearing in the Transactions and Journals of the American Ceramic Society[1]

Porcelain, Whiteware and Allied Products

"A Study of the Vitrification Range and Di-Electric Behavior of Some Porcelains," *Trans.*, **12** (1910).

"The Measurement of Color of Whiteware and Whiteware Materials," *Trans.*, **13** (1911).

"High Voltage Insulators and High Potential Testing," *Trans.*, **14** (1912).

"The Viscosity of Porcelain Bodies," *Trans.*, **15** (1913).

"The Clark Viscosimeter," *Trans.*, **15** (1913).

"The Veritas Firing Rings," *Trans.*, **16** (1914).

"Study of the Atterberg Plasticity Method," *Trans.*, **16** (1914).

"Some of the Properties of White Porcelain Cement," *Trans.*, **16** (1914).

"The Viscosity of Porcelain Bodies," *Trans.*, **17** (1915).

"The Bureau of Standards Contrast Method for Measuring Transparency," *Trans.*, **17** (1915).

"Electrical Conductivity of a Porcelain Mixture and a Shale upon Heating," *Trans.*, **17** (1915).

"Notes on the Manufacture of Porcelain Pyrometer Tubes," *Trans.*, **18** (1916).

"The Constitution and Microstructure of Porcelain," *Trans.*, **18** (1916).

"Notes on the Production of Special Refractories—Marquardt Porcelain and Magnesium Aluminate," *Trans.*, **19** (1917).

"Note on the Temperature, Porosity, Volume Changes of Some Porcelain Bodies," *Trans.*, **19** (1917).

"Some Types of Porcelain," *Jour.*, **1** [9] (1918).

"Note on Certain Characteristics of Porcelain," *Jour.*, **1** [10] (1918).

"Effect of Time and Temperature on the Microstructure of Porcelain," *Jour.*, **2** [3] (1919).

---

[1] Copies of the *Transactions* and *Journals* may be consulted at leading libraries or may be obtained from the Secretary of the Society at Lord Hall, O. S. U., Columbus, Ohio.

"Impact Tests and Porosity Determinations on Some American Hotel China and Semi-Porcelain Plates," *Jour.*, **2** [3] (1919).

"Some Physical Properties of American Commercial Porcelain Bodies," *Jour.*, **2** [4] (1919).

"Special Spark Plug Porcelains," *Jour.*, **2** [7] (1919).

"Relation between the Composition and the Thermal Expansivity of Porcelain," *Jour.*, **2** [10].

"Further Studies on Porcelain," *Jour.*, **2** [10] (1919).

"The Solubility of Boric Acid Frits," *Jour.*, **3** [2] (1920).

"The Rate of Vitrification of Porcelain Molded under Different Conditions," *Jour.*, **3** [10] (1920).

"Solubility and Fusibility of Some Feldspar Frits," *Jour.*, **4** [6] (1921).

"High-Fire Porcelain Glazes," *Jour.*, **4** [9] (1921).

"Note on the Hardness of Glazes," *Jour.*, **4** [11] (1921).

"Earthenware Bodies and Glazes," *Jour.*, **4** [12] (1921).

"Comparative Tests of American and Foreign Tableware," *Jour.*, **5** [6] (1922).

"Impact Tests on Tableware," *Jour.*, **6** [2] (1923).

"The Effect of Variation in Firing on the Physical Properties of Vitreous China Bodies," *Jour.*, **6** [8] (1923).

"The Bonding Effect of Ball Clays in Fired Bodies," *Jour.*, **7** [2] (1924).

"An Apparatus for Measuring the Abrasive Hardness of Glazes," *Jour.*, **7** [5] (1924).

Refractories and Heavy Clay Products

"The Relation between the Porosity and Crushing Strength of Clay Products," *Trans.*, **12** (1910).

"The Behavior of Fire Bricks under Load Conditions at a Temperature of 1300°C," *Trans.*, **12** (1910).

"The Behavior of Fire Bricks under Load Conditions," *Trans.*, **13** (1911).

"The Relation between the Crushing Strength and Porosity of Clay Products," *Trans.*, **14** (1912).

"Notes on Load Tests Made on Magnesite, Chrome, and Silica Brick," *Trans.*, **14** (1912).

'The Melting Points of Refractory Materials," *Trans.*, **15** (1913).

"The Development of Special Refractory Bodies," *Trans.*, **15** (1913).

"Report on Rattler Tests Made on Brick Obtained from Paved Streets," *Trans.*, **16** (1914).

"The Relative Thermal Conductivities of Silica and Clay Refractories," *Trans.*, **16** (1914).

"Effect of Saturated Sodium Sulphate Solution upon the Structure of Clay Burned to Different Temperatures," *Trans.*, **17** (1915).

"Notes on Casting," *Trans.*, **17** (1915).

"A Method of Testing the Corrosive Action of Slag on Fire Brick," *Trans.*, **18** (1916).

"Note on the Volume Changes of Silica Brick Mixtures," *Trans.*, **18** (1916).

"Volume Changes of Some Commercial Silica Bricks on Heating," *Trans.*, **19** (1917).

"The Effect of Size of Grog in Fire Clay Bodies," *Trans.*, **19** (1917).

"Special Pots for the Melting of Optical Glass," *Jour.*, **1** [1] (1918).

"Porosity and Volume Changes of Clay Fire Brick at Furnace Temperatures," *Jour.*, **1** [6] (1918).

"Silica Refractories," *Jour.*, **1** [7] (1918).

"The Equipment of a Casting Plant for the Manufacture of Glass Pots," *Jour.*, **2** [8] (1918).

"Note on the Casting of Porcelain Glass Pots," *Jour.*, **2** [8] (1919).

"Siliceous Sagger Mixtures," *Jour.*, **3**, [1] (1920).

"Notes on the Load Behavior of Aluminous Refractories," *Jour.*, **3** [2] (1920).

"Notes on Porcelain Glass Pot Mixtures," *Jour.*, **3** [7] (1920).

"The Transverse Strength of Fire-Clay Tiles at Furnace Temperatures," *Jour.*, **4**, [7] (1921).

"Possibilities of Terra Cotta Castings," *Jour.*, **4** [11] (1921).

"Study of Some Bond Clay Mixtures," *Jour.*, **4** [11] (1921).

"Effectiveness of Different Methods of Making Absorption Determinations as Applied to Hollow Building Tile," *Jour.*, **5** [11] (1922).

"Capping for Compression Specimens," *Jour.*, **6** [5] (1923).

"Effect of Grog Additions on Fire Resistance of Hollow Tile," *Jour.*, **6** [6] (1923).

"Further Studies on Cast Glass Pots," *Jour.*, **6** [8] (1923).

"Progress Report on Specifications for Refractories," *Jour.*, **6** [10] (1923).

"Strength, Absorption and Freezing Resistance of Hollow Building Tile," *Jour.* **7** [3] (1924).

"Notes on the Behavior of Refractories in Glass Melting Furnaces," *Jour.*, **7** [8] (1924).

"The Laboratory Testing of Aluminous Refractories," *Jour.*, **7** [9] (1924).

Vitreous Enamels

"Ground Coat Enamels for Cast Iron," *Jour.*, **1** [2] (1918).

"Preparation and Application of Enamels for Cast Iron," *Jour.*, **1** [8] (1918).

"Control of Luster of Enamels," *Jour.*, **1** [9] (1918).

"Enamels for Cast Iron," *Jour.*, **1** [10] (1918).

"The Cleaning of Sheet Steel and Iron for Enameling Purposes," *Jour.*, **2** [11] (1919).

"Classification of Enamels for Sheet Steel," *Jour.*, **3** [12] (1920).

"The Cause and Control of Fish Scaling of Enamels for Sheet Iron and Steel," *Jour.*, **4** [8] (1921).

"Some Relations of Composition to Solubility of Enamels in Acids," *Jour.*, **4** [9] (1921).

"The Production of Some White Enamels for Copper," *Jour.*, **4** [10] (1921).

"Wet Process Enamels for Cast Iron," *Jour.*, **5** [10] (1922).

"The Effect of Some Substitutes for Tin Oxide on the Opacity of White Enamels for Sheet Steel," *Jour.*, **6** [5] (1922).

"The Relations between Composition and Properties of Enamels for Sheet Steel," *Jour.*, **6** [10] (1922).

"Factors Affecting the Warpage of Sheet Iron and Steel in Enameling," *Jour.*, **7** [5] (1924).

"The Development of Some Jewelry Enamels," *Jour.*, **7** [12] (1924).

Glass

"Variation in Soda, Lime, and Magnesia Content of a Glass of the Type RO_3SiO_2," *Trans.*, **17** (1915).

"Observations on the Formation of Seeds in Optical Glass," *Jour.*, **1** [2] (1918).

"Strength Tests of Plain and Protective Sheet Glass," *Jour.*, **1** [11] (1918).

"Procedure in the Manufacture of Optical Glass," *Jour.*, **2**, [6] (1919).

"Production of Selenium Red Glass," *Jour.*, **2** [11] (1919).

"Comparison Tests for Striae in Optical Glass by the Brashear Converging Light, Direct View Method, the Bureau of Standards Tank Immersion Method, and the Short, Range Projection Method," *Jour.*, **2** [12] (1919).

"Disintegration of Soda-Lime Glasses in Water," *Jour.*, **5** [8] (1922).

"The Microscopic Identification of Stones in Glass," *Jour.*, **7** [1] (1924).

"Tests on the Resistive Qualities of Soda-Lime Glasses to Water," *Jour.*, **6** [4] (1923).

"A Study of the Origin and Cause of Stones in Glass," *Jour.*, **6** [6] (1923).

"The Mechanical Strength of Glazing Glass," *Jour.*, **6** [9] (1923).

MISCELLANEOUS

RAW MATERIALS—THEIR PROPERTIES, USES AND METHODS OF TESTING

"Note on the Viscosity of Clay Slips as Determined by the Clark Apparatus," *Trans.*, **12** (1910).

"Notes on the Preheating Treatment of Clays," *Trans.*, **12** (1910).

"The Dehydration of Clays," *Trans.*, **14** (1912).

"The Effect of Overburning on the Structure of Clays," *Trans.*, **15** (1913).

"Function of Time in the Vitrification of Clays," *Trans.*, **15** (1913).

"The Electrical Conductivity of Clays and Clay Suspensions," *Trans.*, **15** (1913).

"Study of Some Calcareous and Magnesium Slags," *Trans.*, **15** (1913).

"The Temperature Porosity Relations of a Clay Prepared in the Plastic and in the Moist Condition," *Trans.*, **15** (1913).

"A Note on the Reduction of Fe_2O_3," *Trans.*, **16** (1914).

"The Compression, Tensile, and Transverse Strength of Some Clays in the Dried States," *Trans.*, **16** (1914).

"The Flow of Clays under Pressure," *Trans.*, **16** (1914).

"A Laboratory Oven Provided with Recording Attachments for the Study of Drying Clays," *Trans.*, **16** (1914).

"Viscosity of Some Shales at Furnace Temperatures," *Trans.*, **16** (1914).

"The Use of Deflocculating Agents in the Washing of Clays and the Effect of the Process upon the Color," *Trans.*, **17** (1915).

"Note on Thermal Electric Phenomena Observed in Some Silicates," *Trans.*, **17** (1915).

"A Study of Fire Clay, Shale, and Surface Clay Mixtures with Reference to Their Porosity Temperature Relations," *Trans.*, **17** (1915).

"The Relation between the Modulus of Elasticity and the Porosity of Burned Clay," *Trans.*, **17** (1915).

"Deformation of Plastic Bodies under Compression as a Measure of Plasticity," *Trans.*, **17** (1915).

"Microscopic Investigation of Some Compounds Noted in the Systems Soda–Zinc Oxide–Silica and Soda–Zinc Oxide–Titanic Oxide–Silica," *Trans.*, **17** (1915).

"On the Attainment of Reliable Temperature Measurements in the Ceramic Industries by Means of Thermocouples," *Trans.*, **18** (1916).

"Softening Points of Potash, Feldspar–Steatite Mixtures," *Trans.*, **18** (1916).

"Heat Balance of a Continuous Tunnel Kiln," *Trans.*, **19** (1917).

"An Instrument for Measuring Plasticity," *Trans.*, **19** (1917).

"Properties of Some American Bond Clays," *Trans.*, **19** (1917).

"Test of a Producer Gas-Fired Periodic Kiln," *Jour.*, **1** [1] (1918).

"Tests of Clays and Limes by the Bureau of Standards Plasticimeter," *Jour.*, **1** [3] (1918).

"Applications of the Polarizing Microscope in Ceramics," *Jour.*, **2** [9] (1919).

"The Use of American Raw Materials in the Manufacture of Whiteware Pottery," *Jour.*, **3** [2] (1920).

"The Testing of Clays for Concrete Aggregate," *Jour.*, **3** [3] (1920).

"Effect of Aluminum Chloride upon Clays," *Jour.*, **3** [12] (1920).

"Use of American Raw Materials in the Manufacture of Whiteware Pottery," *Jour.*, **3** [12] (1920).

"Note on the Effect of Time on the Drying Shrinkage of Clays," *Jour.*, **4** [4] (1921).

"The Water Smoking of Clays," *Jour.*, **4** [5] (1921).

"Absorption of Sodium Hydroxide by Kaolins," *Jour.*, **4** [6] (1921).

"Use of Special Oxides in Porcelain Bodies," *Jour.*, **4** [10] (1921).

"The Plasticity of Clays," *Jour.*, **5** [6] (1922).

"Comparative Tests of Foreign and Domestic Whiting," *Jour.*, **5** [12] (1922).

"Effect of Hydrogen Ion Concentration upon Clay Suspensions," *Jour.*, **6** [9] (1923).

"Thermal Expansion of Fused Quartz," *Jour.*, **7** [11] (1924).

REVISED LIST OF PUBLICATIONS ON CERAMIC INVESTIGATIONS—BUREAU OF MINES[1]

The following list gives the title and author of various publications of the Ceramic Experiment Station, Columbus, Ohio, of the Bureau of Mines, together with other ceramic publications of the Bureau, which have been published in technical journals and by coöperating agencies. The list also includes the publications on ceramics which have been issued as bulletins, technical papers, or mimeograph Report of Investigations of the Bureau.

Papers Published in the Technical Press

H. G. Schurecht, "The Effect of Some Electrolytes on the Properties of Clays," *Jour. Amer. Ceram. Soc.*, **1** [3], 201 (1918).

H. G. Schurecht, "A Pycnometer Operated as a Volumeter," *Jour. Amer. Ceram. Soc.*, **1** [8], 556 (1918).

H. G. Schurecht, "The Properties of Some Ohio and Pennsylvania Stoneware Clays," *Jour. Amer. Ceram. Soc.*, **1** [4], 267 (1918).

M. C. Booze, "The Fusibility of Graphite Ash and Its Influence on the Refractoriness of Bond Clay," *Jour. Amer. Ceram. Soc.*, **2** [1], 65 (1919).

R. T. Stull, "Behavior under Brass Foundry Practice of Crucibles Containing Ceylon, Canadian and Alabama Graphites," *Jour. Amer. Ceram. Soc.*, **2** [3] (1919).

H. G. Schurecht, "Experiments in Dead-Burning Dolomite," *Jour. Amer. Ceram. Soc.*, **2** [4], 291 (1919).

R. T. Stull and H. G. Schurecht, "Effect of Variable Pressure and Tar Content on the Briquetting of Alabama Graphite," *Jour. Amer. Ceram. Soc.*, **2** [5], 391 (1919).

M. C. Booze, "Some Properties of Bond Clays for Graphite Crucibles," *Jour. Amer. Ceram. Soc.*, **2** [6], 461 (1919).

H. G. Schurecht, "The Effect of Electrolytes on the Properties of Graphite Crucible Bodies," *Jour. Amer. Ceram. Soc.*, **2** [6], 443 (1919).

H. G. Schurecht, "A Machine for Testing the Hot Crushing Strength of Firebrick," *Jour. Amer. Ceram. Soc.*, **2** [8], 602 (1919).

R. T. Stull, "The Position of Clay Products in the Field of Earthen Products," *Brick & Clay Record*, March 6 (1919).

R. T. Stull, "Graphites and Bond Clays for Crucible Making Purposes," Proc. 22nd Convention, Am. Mining Congress, p. 766, November 17–21 (1919).

[1] Compiled by L. E. Geyer, Bureau of Mines.

R. T. Stull, "The Need of Technical Assistance in the Brick Industry," *Jour. Amer. Ceram. Soc.*, **3** [3], 180 (1920).

R. T. Stull, "Government Service in Developing the Clay Industry," *The Clay Worker*, March 25 (1920).

H. G. Schurecht, "Elutriation Tests on American Kaolins," *Jour. Amer. Ceram. Soc.*, **3** [5], 355 (1920).

H. G. Schurecht, "Behavior of Firebrick in Malleable Furnace Bungs," *Jour. Amer. Ceram. Soc.*, **3** [7], 556 (1920).

R. N. Long, "The Fusibility of Mixtures of Graphite Ash and Bond Clays," *Jour. Amer. Ceram. Soc.*, **3** [8], 626 (1920).

H. G. Schurecht, "A Direct Reading Overflow Volumeter," *Jour. Amer. Ceram. Soc.*, **3** [9], 730 (1920).

R. T. Stull, "Some Properties of Refractories," *Proc. Elec. Fur. Assn.*, Niagara Falls, N. Y., Oct. 6, 1920.

H. W. Douda, "The Effect of Wet Grinding, Screening and Electrolytes and Dextrins on Clays of Low Plasticity," *Jour. Amer. Ceram. Soc.*, **3** [11], 885 (1920).

H. G. Schurecht, "Experiments in Aventurine Glazes, *Jour. Amer. Ceram. Soc.*, **3** [12], 971 (1920).

H. G. Schurecht, "Experiments in Dead-Burning Dolomite and Magnesite," *Jour. Amer. Ceram. Soc.*, **4** [2], 127 (1921).

H. G. Schurecht, "Some Properties of Bodies and Glazes Used in the Pottery Industry, together with Notes on Lusters and Aventurine Glazes," *N. J. Ceramist*, **1** [1], March (1921).

H. G. Schurecht, "Note on the Effects of Firing Temperatures on the Strength of Fireclay and Stoneware Bodies," *Jour. Amer. Ceram. Soc.*, **4** [5], 366 (1921).

H. G. Schurecht, "The Separation of Lime from Dolomite," *Jour. Amer. Ceram. Soc.*, **4** [7], 558 (1921).

H. G. Schurecht, "Sedimentation as a Means of Classifying Extremely Fine Clay Particles," *Jour. Amer. Ceram. Soc.*, **4** [10], 812 (1921).

R. T. Watkins, "The Degree to Which Different Glaze Compositions Take Vapor Lusters," *Jour. Amer. Ceram. Soc.*, **5** [1], 28 (1922).

H. G. Schurecht, "The Microscopic Examination of the Mineral Constituents of Some American Kaolins," *Jour. Amer. Ceram. Soc.*, **5** [1], 3 (1922).

G. A. Bole, "Mechanism of Plasticity from Colloid Standpoint," *Jour. Amer. Ceram. Soc.*, **5** [8], 469 (1922).

R. B. Gilmore and A. H. Fessler, "An Account of an Investigation of Some Georgia Clays and Bauxites," *Bull. Amer. Ceram. Soc.*, **1** [9], 193 (1922).

G. A. Bole and F. G. Jackson, "A Simple Control Porosimeter," *Brick and Clay Rec.*, **61** [5], Sept. 5 (1922).

H. G. Schurecht, "The Mechanical Movement of Water through Clays and Its Control," *Jour. Amer. Ceram. Soc.*, **5** [12], 928 (1922).

F. G. Jackson and L. I. Shaw, "The Purification and Analysis of Zirconium Oxide," *Jour. Amer. Chem. Soc.*, Dec. (1922).

H. G. Schurecht, "Note on a Direct Reading Automatic Laboratory Scale for Weighing Briquettes," *Jour. Amer. Ceram. Soc.*, **6** [3], 491 (1923).

H. G. Schurecht and H. W. Douda, "The Properties of Some Clay-Like Materials of the Bentonite Type," *Jour. Amer. Ceram. Soc.*, **6** [8], 940 (1923).

Stout, Stull, Demorest and McCaughey, "Coal Formation Clays of Ohio," Ohio Geo. Surv., *Bull.* **26,** 4th series (1923).

H. Wilson, A. L. Bennett, and F. T. Heath, "Preliminary Report on the Residual

Kaolins and Feldspars in the Pacific Northwest," *Jour. Amer. Ceram. Soc.*, **6** [3], 475 (1923).

Hewitt Wilson, "Clays and Shales in the State of Washington, their Technology and Uses," Wash. State, *Bull.* (1922).

E. A. Goodner, "A Mercury Volumeter," *Jour. Amer. Ceram. Soc.*, **4** [4], 288 (1921).

R. T. Stull and G. A. Bole, "Refractory Possibilities of Some Georgia Clays," *Jour. Amer. Ceram. Soc.*, **6** [5], 663 (1923).

R. T. Stull and G. A. Bole, "Washing Tests of Georgia Clays," *Jour. Amer. Ceram. Soc.*, **6** [6], 730 (1923).

G. A. Bole and R. T. Stull, "Use of Sedimentary Kaolins of Georgia in White Wares," *Jour. Amer. Ceram. Soc.*, **6** [7], 854 (1923).

H. G. Schurecht and H. W. Douda, "Behavior of Fire Brick in Malleable Iron Furnace Bungs," *Jour. Amer. Ceram. Soc.*, **6** [12], 1232 (1923).

J. T. Robson and J. R. Withrow, "The Dead Burning of Dolomite," *Jour. Amer. Ceram. Soc.*, **7** [1, 2, 3, 4, 5], 61, 141, 207, 302, 397 (1924).

E. E. Pressler, "A Simple Brick Porosimeter," *Jour. Amer. Ceram. Soc.*, **7** [3], 154 (1924).

G. A. Bole and F. G. Jackson, "The Oxidation of Ceramic Wares during Firing (in 6 parts)," *Jour. Amer. Ceram. Soc.*, **7** [3, 4, 5, 6, 7, 8], 163, 223, 382, 427, 532, 634, 656 (1924).

R. T. Stull and G. A. Bole, "Utilization of Georgia Kaolins in the Manufacture of Face Brick," *Jour. Amer. Ceram. Soc.*, **7** [5], 347 (1924).

B. M. O'Harra, "Metallurgical Requirements of Refractories in the Electrothermic Metallurgy of Zinc," *Jour. Amer. Ceram. Soc.*, **6** [11], 1180 (1923).

R. A. Sherman, "Combustion in Kilns Burning Refractory Ware," *Jour. Amer. Ceram. Soc.*, **7** [3], 175 (1924).

H. W. Gillett and E. L. Mack, "The Electric Brass Furnace Refractory Situation," *Jour. Amer. Ceram. Soc.*, **7** [4], 288 (1924).

R. A. Sherman, Robert Lunger, and W. E. Rice, "The Significance of Drafts in Down-Draft, Coal Fired Kilns," *Jour. Amer. Ceram. Soc.*, **7** [4], 255 (1924).

A. I. Andrews, "The Making of Dolomite Brick and a Study of their Properties," *Jour. Amer. Ceram. Soc.* (in print).

J. G. Phillips, "The Cause for the Expansion of Flint Fire Clay During Heat Treatment," Ohio State University, *Eng. Expt. Sta., Bull.* (in print).

F. T. Heath, "The Utilization of Pebbly Clays for the Manufacture of Heavy Clay Products," Ohio State University, *Eng. Expt. Sta., Bull.* (in print).

A. V. Henry, "Electrical Resistivity of Refractories," *Jour. Amer. Ceram. Soc.*, **7** [10], Oct. (1924).

F. G. Jackson, "Some Reactions of a Well-Known Fireclay," *Jour. Amer. Ceram. Soc.*, **1** [3], 163 (1923).

W. M. Weigel, "Georgia Clays for Paper Fillers," *Paper Trade Jour.* (1923).

C. E. Williams, "Refractories for Electric Furnace," *Am. Electrochem. Soc.* (1923).

H. G. Schurecht, "Utilization of Dolomite and Magnesite." To be published by *Jour. Amer. Ceram. Soc.*

Eugene E. Pressler, "Comparative Tests of Porosity and Specific Gravity on Different Types of Refractory Brick," *Jour. Amer. Ceram. Soc.*, **7** [6], 447 (1924).

G. S. Tilley and J. D. Sullivan, "Note on the Rational Analysis of Clays," *Jour. Amer. Ceram. Soc.*, **7** [5], 379 (1924).

Frank Porter, "An Automatic Toepler Pump," *Ind. and Eng. Chem.* (1924).

W. M. Weigel, "Georgia Clays for Rubber Fillers, presented before Amer. Chem. Soc. meeting Apr. 21, 1924, Washington, D. C.

Mayo D. Hersey and Edward W. Butzler, "Determination of Thermal Conductivity of Refractories," *Wash. Acad. Sci.* (1924).

Clyde E. Williams, "Operating Conditions in the Open Hearth Furnace as They Affect Refractories," *Jour. Amer. Ceram. Soc.*, **7** [9], 681 (1924).

H. C. Harrison, "Roof Brick for the Open Hearth," *Jour. Amer. Ceram. Soc.*, **7** [9], 698 (1924).

R. J. Anderson, "Metallurgical Requirements of Refractories," *Jour. Amer. Ceram. Soc.*, **6** [10], 1090 (1923).

F. W. Davis, "Outline of Refractory Requirements for the Iron and Steel Industry," *Jour. Amer. Ceram. Soc.*, **6** [11], 1183 (1923).

W. E. Rice and R. A. Sherman, "Determination of the Distribution of Heat in Kilns Burning Clay Wares," *Jour. Amer. Ceram. Soc.*, **7** [10], 738 (1924).

Issued as a Publication of the Bureau of Mines

Bulletins

A. S. Watts, "Mining and Treatment of Feldspar and Kaolin in the Southern Appalachian Region," **Bull.* **53** (1913). Out of print.

A. S. Watts, "Feldspars of the New England and Northern Appalachian States," ***Bull.* **92** (1916), 25 cents.

G. D. Dub and F. G. Moses, "Mining and Preparing Domestic Graphite for Crucible Use," *Bull.* **112** (1920).

I. E. Sproat, "Refining and Utilization of Georgia Kaolins," ***Bull.* **128** (1916), 15 cents.

Technical Papers

A. S. Watts, "Probable Effect of the War in Europe on the Ceramic Industries of the United States," *Tech. Paper* **99** (1915). Out of print.*

T. G. McDougal, "The Casting of Clay Wares," ***Tech. Paper* **126** (1916), 5 cents.

A. C. Fieldner, W. A. Selvig and G. B. Taylor, "The Determination of Combustible Matter in Silicate and Carbonate Rocks," *Tech. Paper* **212** (1919).

H. G. Schurecht, "The Properties of Some Stoneware Clays," ***Tech. Paper* **233** (1920), 10 cents.

H. G. Schurecht, "The Use of Electrolytes in Purifying Clays," *Tech. Paper* **281** (1922).

Reports of Investigations

W. C. Phalen, "Magnesite," Serial No. **2010** (1919).

W. C. Phalen, "Magnesite Industry in Austria," Serial No. **2015** (1919).

W. C. Phalen, "Magnesite," Serial No. **2025** (1919).

L. H. Duschak, "The Determination of Free Calcium Oxide in Caustic Burned Magnesium Oxide," Serial No. **2138** (1920).

D. A. Lyon, "The Work of the Ceramic Station of the Bureau of Mines at Columbus, Ohio, in Behalf of the Ceramic Industry," Serial No. **2212** (1921).

R. B. Ladoo, "Conditions in the Feldspar Industry," Serial No. **2311** (1922).

---

* Can be consulted at most public libraries.

** Obtainable only through the Superintendent of Documents, Government Printing Office, Washington, D. C., at the price indicated.

W. M. Weigel, "The White Clay Industry in the Vicinity of Langley, South Carolina," Serial No. **2382** (1922).

Clyde E. Williams, "Production of Alumina from Clay Tests on the Miguet Process," Serial No. **2393** (1922).

R. T. Stull and G. A. Bole, "Graphite for Steel Melting Crucibles," Serial No. **2512.**

R. T. Stull and L. E. Geyer, "Graphite for Brass Melting Crucibles," Serial No. **2542.**

Mayo D. Hersey and Edward W. Butzler, "Conductivity and Specific Heat of Refractories at High Temperatures," Serial No. **2564** (1924).

G. A. Bole, "The Utilization of Dolomite for Refractories," Serial No. **2627** (1924).

CALENDAR OF CONVENTIONS

Organization	Date	Place
AMERICAN CERAMIC SOCIETY (Annual Meeting)	Feb. 16–21, 1925	Columbus, Ohio
Am. Assn. of Flint and Lime Glass Mfrs. (Annual Meeting)	July, 1925	Atlantic City, N. J.
Am. Electrochemical Soc.	April 23–25, 1925	Niagara Falls, N. Y.
Am. Soc. for Testing Materials	June 22–26	Atlantic City, N. J.
Am. Concrete Institute	Feb. 24–27, 1925	Chicago, Ill.
Brussells International and Commercial Fair	March 25–April 8	Brussells, Belgium
Common Brick Mfrs. Assn.	Feb. 9–13, 1925	Chicago, Ill.
Manufacturing Chemists' Assn.	June, 1925	New York City
Natl. Assn. of Mfrs.	May, 1925	New York City
Natl. Assn. of Mfrs. of Pressed and Blown Glassware	March, 1925	Pittsburgh, Pa.
Natl. Assn. of Stove Mfrs.	May 13–14, 1925	New York City
Natl. Chemical Equipment Assn.	June 22–27, 1925	Providence, R. I.
Natl. Clay Products Industries Assn.	April, 1925	Chicago, Ill.
Natl. Lime Association	May, 1925	
Natl. Exposition of Chem. Industries	Sept. 28–Oct. 3, 1925	New York City
Tile & Mantel Contractors' Assn. of America	Feb. 9, 1925	Louisville, Ky.

BULLETIN

of the

American Ceramic Society

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

Vol. 4 | March, 1925 | No. 3

EDITORIALS

THE BEGINNINGS OF CERAMIC EDUCATION IN THE UNITED STATES[1]

By Edward Orton, Jr.

The sense in which the phrase, "The beginnings of ceramic education" is used, is open to two interpretations. The simple and obvious meaning, of course, deals with the formal establishment of a school and the beginning of class work. But I venture to say that never did any educational movement actually have its beginnings on the opening day of a school. A school, if it ministers to a real need of mankind, is sure to have its roots deep down in years of groping and more or less inarticulate quest on the part of great numbers of people. And, by that same token, the real beginnings of education in any subject are found when some student and thinker produces and gives to his kind a scholarly achievement in that subject, be it a history, discovery, or prophesy, anything which clarifies hazy thought—which crystallizes views and opinions—which enables the mind to visualize what it could not previously isolate from other partly known or partly guessed facts.

I take it that on this occasion, it is to this second or broad aspect of the

[1] Address on the Thirtieth Anniversary of Ceramic Education, held at the Ohio State University, Monday, February 16, 1925.

subject that we should devote ourselves, especially as what need be said upon the first can be well covered in but little space.

In the sense, then, that education means scholarship rather than schooling, ceramic education in the United States had its rise chiefly in two contributing streams, which flowing more or less parallel for a time finally came together with the establishment of the first ceramic school. These two streams were first, the work of mining engineers and metallurgists, to whom silicate chemistry chiefly meant the art of controlling the formation of fluid slags in their furnaces, to the end that they might separate the metal from its ore, and secondly, the work of the economic geologists, who felt that their mission in life was to tell what our mineral resources were, and for what they might conceivably be used.

It would not be fair to wholly exclude from a share of this early scholarship, the representatives of the ceramic industries themselves, or to deny that the cravings for better knowledge on the part of clay workers did add its quota to the growing science. But to follow the analogy used earlier, their early contributions to the technology of ceramics in this country were as a small rivulet compared to the two main streams above set forth.

The work of the mining engineers and metallurgists, for they were both the same thing in those days, necessarily concerned itself as before stated with slag production. They were the first to teach in the technical schools of this country the art of practical control of silicate melts. In their search for rational practical rules for varying the fusibility of silicate melts, they devised and used the oxygen ratios of the basic and acid constituents of the slag. They borrowed from mineralogy the crude molecular formulas by which mineral compositions were then indicated or guessed at. In the variety of bases existing in and apparently entering into perfect combination in the commonest silicate minerals, and in the fluctuating ratios in which they seemed able to take part in the formation of an apparently definite crystalline compound, they found the warrant for using fractional molecular formulas for expressing the constitution of these slags. And they found these ratios, however unscientific the conception of fractional molecules might be, the only practical or fruitful way to get at the question of silicate formation and control, so vital to their business.

Another thing which the metallurgist taught us was that the physical characteristics of a melt might be predicted on the basis of this same fractional molecular formula or oxygen ratio. He produced slags ranging from fairly perfect transparent glasses, all the way down through the vitreous, the vitrified, the stony, to the crumbling self-slaking material which set into an hydraulic cement on exposure to weather. Thus his work tied into that of the glassmaker on the one end, then the clayworker, and finally on the other extreme the cement manufacturer, and showed all through their kinship and the key to their common problems.

In still another way, the metallurgist touched upon the field of the future ceramist, *viz.*, in his study and use of refractory materials. To the metallurgist, these are the key to his business, the *sine qua non* of successful operation. The metallurgist seldom if ever devoted to the study of clays or other refractories any very extended attention, other than to settle the apparent cause of failures and unsatisfactory results in his furnace walls and hearths. In other words, his studies were more or less impatiently diverted from what he considered his real field—the metals, their ores and their reduction, to the clays, the quartz or the basic minerals used to hold his molten fluids in their crucibles. But, whether he studied clays because he liked to, or because he had to, matters not, for he very successfully established the fundamental principles of the art of making refractory materials, and choosing the appropriate refractory for a given purpose.

In these three several ways then, the metallurgist had laid the foundations for the ceramist before the latter began to claim his field, the use of fractional molecular formulas to express the ratios of silicate compositions, the association of physical properties with molecular ratios in silicate melts, and the use and theory of making heat resisting minerals for furnaces.

The great avenue through which these researches were made available to engineers, chemists and metallurgists was through the Transactions of the American Institute of Mining Engineers. This great society was for years a powerful figure in metallurgy and chemistry as well as in mining and ore-dressing. There were also some high grade technical journals which published some original matter, such as the *Engineering and Mining Journal* of New York and others. But, in general, these papers reworked the Proceedings of the A. I. M. E. and other scientific and technical bodies, and made them more generally available.

But, while credit must not be withheld to these early metallurgists, mineralogists and chemists, who let in the first light on the foundations of ceramics, it must also be said that they had no special interest in ceramics, were not working in ceramics, and so far as they were concerned, there would probably have been no such thing as ceramic engineering recognized today, if the matter had been left to them. Their contributions to this field were incidental, because in both metallurgy and ceramics, silicate production was an essential element—in the one as a by-product, and in the other as the principal end in view.

The other principal source of help to the clayworker in pre-ceramic school days was the work of the geological surveys of the several states. The economic geologist was perhaps less directly a contributor to the chemical foundations, to ceramic chemistry, if one may use that phrase without offense to our chemical friends who say that chemistry is chemistry and needs no qualifying adjectives, than the metallurgist. He helped,

sometimes, on the mineralogical end, and he forced the clayworker and later the ceramist to broaden his foundations, and to get some conception of the complex mineral mixtures which constitute our clays. Without the work of the geologist, in explaining how rocks are made, and unmade, and the complex combinations, solutions, blendings, washings, elutriations, sedimentations, weatherings and denudations through which the surface materials of the globe are constantly passing, the ceramic chemist would have made slow work in getting a conception of what a clay is, and why it is as it is, and what one may expect of it and what not.

But as in the case of the metallurgist, the interest of the geologist was incidental rather than direct. Clay was to him, and I may say, still is, among the least interesting of all rocks, because of its indefiniteness of composition and character. There is so much of it, that perforce he must treat of it in accounting for his mineral menu, but he has left it to the last, usually, in describing the mineral assets of any region. In the publications of the early geological surveys of the different states, no important treatises on clays or clay resources appeared until pretty much everything more spectacular had been written up.

But gold and silver are not everywhere. Iron, copper, lead and zinc, too, cannot always be depended upon to fill reports. So, in the end, the economic geology volumes got down to the homely rocks and minerals—the sandstones, the limestones and lastly the claystones. And we owe these old surveys a great debt, for they did bring together enough of the mineralogy and geology of clays to make the chemical problems of the clayworker much more intelligible, and his efforts to control composition and properties of ceramic mixtures much more certain than would have been otherwise possible.

But, curiously enough, the early geological surveys made another contribution to ceramic engineering, scarcely less important or fundamental than what they told as of the origin, composition, properties and occurrence of clays. They gave to the world, if not the first, at least the best treatises on the technology of the clay industries. The older books written by clay workers upon the processes of their art are rather heavy and lumbering material, compared to the much better treatises which appeared in the geological reports of various states.

The pioneer of these reports was Cook's Report on the New Jersey Clays published about 1874—which was followed by that of Ohio in 1883 and again in 1893, and that of Wheeler in Missouri in 1897. Many others have followed, but mostly after ceramics had set its seal on this field and usually the later works were done by men of more or less ceramic training. But it is a fact that the first and for a long time practically the only effort to discuss kilns, driers, mechanical processes for forming ware, plant layout and design occurred in the geological survey reports,

and from there they filtered slowly into the trade through direct use of the books and the reworked articles in the trade journals.

It may well be enquired what contributions to ceramic technology, coming directly from the industry, had appeared in English texts as a source of inspiration to the clayworker and ceramist prior to the advent of the schools. There was a very marked paucity of such material. In 1894 an effort was made to obtain everything directly bearing on the science of ceramics in any language for the library of the newly established school. There were in all about 60 or 70 books found, 75% were in German, 15% in French and the remaining 10% were in English, but nearly all discussed English ceramic practice, which differs so markedly from American practice as to afford practically no assistance to our clayworkers here.

In 1895 a little volume appeared, printed in a small edition which was soon exhausted, which marked the turning point in this country. I refer to the "Chemistry of Pottery" by Karl Langenbeck, then chemist of the American Encaustic Tiling Company of Zanesville. This book made at once a profound impression, it was like opening a blind and admitting a brilliant beam of sunshine into a large dark hall. Though it did not illuminate the corners, it gave that first priceless illumination which showed the outlines of the space, and where the corners were. Nothing that has appeared before or since originally in English, has exercised so great an effect. The translation of Seger's "Collected Writings" in 1900 was an epoch-making step to Americans, placing the wealth of Seger's knowledge and his still more valuable methods of approach to ceramic problems in their reach. But that was a foreign book, and came after Langenbeck's by several years.

At this same time, the trade journals in the English language dealing with clayworking were few and not of high grade. No English speaking journal in the early days up to about 1895 or possibly 1900 appeared which compared at all favorably with several of the German technical journals, which were the place of original publication of much of the very best work done by the brilliant and able German, Hermann A. Seger, his pupils and successors. The English and American trade journals were very slow in getting upon a scientific plane and while they helped to circulate what matter did appear in English upon ceramic subjects, it can not truthfully be claimed that they produced much new material, or really added much to human knowledge in this field.

The literature of ceramic art prior to 1900 was abundant, in many languages. Even English had many large and costly treatises, dealing with history, the marks of various potters, illustrations of their wares, and a wealth of material upon the design and embellishment of pottery, tiles, glass and enameled wares of all ages. But this material, of course has

little value to a scientist or engineer, for when the artist, or collector, or connoisseur writes of his specialty, it almost invariably shows the paucity of his knowledge of the chemistry and technology of the subject.

In the foregoing, I have tried to indicate what the situation of the American clayworker and ceramist was, so far as sources of technical information on his business were concerned, in 1894. He had virtually no treatises, and those accessible described an industry wholly different from the clayworking he knew about in practice. He had no journals, excepting those which knew no more than he knew himself. Those which he had did not bring to him the stores of knowledge tied up in scientific literature in foreign tongues and general chemical publications. He had no technical societies of solid scientific or engineering grade. The one clayworking organization of more than local extent in those days was the National Brick Manufacturers' Association—then about six years old, and keenly alive, anxious and ready to use anything that had apparent scientific or engineering merit. But its management was non-technical, and unable to give it scientific guidance, and while the clayworkers of the country owe it much, it has never become an association of professional grade. The clayworker and ceramist did have access to a limited but very valuable literature in metallurgy and geology, if he had the training to understand them, and the ability to apply their lessons to his own problems, which were not the same, though parallel.

It may not be improper to briefly trace the influences and forces which led up finally to the establishment of the first English speaking technical school of engineering grade for clayworkers at this University in 1894.

As usual in all human undertakings, a real step in advance comes from the effort to meet a bitter personal need. It is so with every invention and every discovery, or almost every one. People do not often hunt for things which need doing and deliberately set themselves to do them as a matter of general interest. At least, the day of the research student in pure science had not made itself so evident 30 years ago as it is now. And even the research man, though he may not know to what use, if any, his facts will be put when discovered, is usually working systematically to fill a gap in knowledge with very definite intent.

The personal need which furnished the motive for the effort which resulted in the founding of the first ceramic school was brought out into the open by the effort of an individual trained as a mining engineer, that is to say with some metallurgical, chemical and geological knowledge and experience—to solve the problems of an ordinary clayworking industry. With such an education, and seven years of mining and metallurgical experience behind him, he attempted to operate a paving brick factory, with that sublime confidence which seems to protect the young and inexperienced from the worst consequences of their folly.

It is not necessary here to relate his trials and his failures. Suffice it to say that after two years of top-notch effort, he found that while his experiences did not disprove his chemical and metallurgical conceptions, or make him lose confidence in their basic soundness, they did show him conclusively that his training gave him only a very superficial grasp upon the problems of this ancient industry of clayworking.

Then, by chance, the opportunity came to him to visit in an official capacity, hundreds of ceramic works in Ohio and neighboring states, and to exchange views with their respective leaders, and to endeavor to interpret their troubles and problems. And, out of these conferences, came the realization that here was a mineral industry, one of the greatest, ranking second only to iron and steel in value of output, the oldest probably of all the arts of man, floundering along in the dark, without help, or interpretation, or preparation. And this realization accomplished what the personal need would probably not have accomplished—it would have been easier to change back to metallurgy or mining again. It brought the determination, in behalf of the thousands of men struggling along in the dark, to provide a means whereby the principles of chemistry and physics and geology and metallurgy could be applied specifically to the field of the ceramist, and whereby young men might be trained to draw their illustrations and make their analogies and work out their theories in terms of clays, and glazes, and enamels, instead of with metals and slags. It is the same chemistry and physics and mathematics, no matter to what it is applied, but the human mind is not often so keen that its logic can cleave mercilessly through all the entanglements of the unfamiliar, and at once strip the problem down to its bare bones. Once in a generation does such a thinker appear. But most men's vision does not go materially beyond the field of their experience, and the training of chemists to work in clays is just as logical and just as necessary to progress as to train them to work in metals, or in dyes or in physiological serums.

So, out of the combination of personal need and a realization of the widespread need of others, the determination to start this school took form. It was a rash, almost a fool-hardy venture. It could never have taken place in any other country but our blessed America. But here, thank heaven, anybody can usually get the chance to make a fool of himself in his own way, at least once—and sometimes his folly leads to success.

The actual steps of the founding of the first clayworkers' school—the working up of the project—the solicitation of support of the clayworkers—the enlisting of the aid of organizations—the passage of an enabling act by the legislature—the final passage of the appropriation and the beginning of the work, do not offer anything of special novelty or outstanding interest, and the story has been told several times before. But, of all of that loyal group of people, many of them far from sure that the proposal was possible

of success, or of much value if successful, who worked so hard to put the proposition over, and who rejoiced so heartily when it was at least assured, there can hardly be one today who is not deeply grateful that he was so fortunate as to have had a hand in the beginnings of an enterprise, whose effects have been so far reaching and whose influence has been so mighty.

THIRTY YEARS PROGRESS IN CERAMIC EDUCATION[1]

By A. V. Bleininger

Ceramic education during its early period was undoubtedly built upon the work of H. A. Seger, and too much credit cannot be given to the clear and logical premises which he established. Seger's work was of the quality which endures, and much of what he said holds today as it did forty years ago. His was the true scientific spirit, searching humbly for the truth.

Building upon the foundation erected by Seger but broadening the scope of research, our Professor Orton erected the superstructure of American ceramic technology which he at once widened into a conception which included all silicates used or produced in the industrial arts.

The mode of attack employed by the Orton school of ceramic technology was that of a refined empiricism built upon the chemical and physical conceptions current at that time. There was a strong leaning toward the use of the methods of metallurgy as exemplified by the contributions of the American Institute of Mining Engineers, which at that time was in the full flower of its virile existence. This was but natural since Professor Orton was by profession a metallurgical engineer.

The difficulties involved in the precise study of the clay silicates then, as now, were great. Even the chemical analysis of the silicates is a slow and laborious operation and to obtain an insight into the real structure of the raw or fired materials it was necessary to resort to the employment of indirect methods and the measurement of such phenomena as loss in weight and contraction in volume. Clays are such poorly defined, opaque arrangements of mineral matter that even under the modern methods of microscopic examination they only yield partially to the experienced petrographer. At that time the conceptions of colloidal chemistry were entirely absent.

The situation was somewhat different as regards glass which, owing to its physically more homogeneous character, and its transparency, was capable of being studied with greater facility. We find thus as early as 1881 that systematic investigation of glass was begun at Jena which yielded

---

[1] Address on the Thirtieth Anniversary of Ceramic Education, Ohio State University, Feb. 16, 1925.

that remarkable series of studies by Abbé and Schott which have become classic, and which still offer a fine example of how the physical properties of a substance may be correlated with its chemical composition.

Again, in the case of the hydraulic silicates, particularly Portland cement, their crystalline character offers a means of direct attack through petrographic study. In this field that master investigator, H. Le Chatelier, gave us the first insight into the nature of Portland cement in 1887.

Since all the igneous reactions of the silicates involve as determining factors both temperature and time, it is obvious that one of the main requisites for study in this field was the accurate measurement of the more elevated temperatures. This was afforded by the introduction of the thermoelement and the high resistance millivoltmeter. One of the first instruments installed by Professor Orton was a pyrometer of this type. It is questionable whether Orton could have conducted his classical work on the oxidation of carbon in clays without the aid of these more precise means of measuring high temperatures. At least it could not have been done so well. This topic cannot be dismissed without some reference to the early work of the newly created Bureau of Standards on pyrometry which was of great importance in assisting in this development.

Gradually, then, our more or less empirical studies yielded to conceptions introduced through the development of the fundamental sciences. But it must be realized that in meeting the demand of the industries for specific information it was difficult to avoid the use of the methods which had produced useful results more rapidly than the precise but time consuming measurements of the physical and chemical laboratory. Pioneering work cannot always be choice in the means of its progress.

At the same time we were confronted with the necessity of assimilating and correlating the vast experience of practical industry. For decades there had accumulated a large stock of practical information, and it became imperative that this be studied and classified. Without an acquaintance with this reservoir of knowledge any contemplated work would often be a duplication or misdirection of effort. This aspect of ceramic investigation must not be neglected, and it explains why very often laboratory studies are carried on which have been solved in practice many years ago.

Physical chemistry finds itself at a disadvantage when dealing with silicate reactions which take place at furnace temperatures, and which are limited by physical heterogeneity, enormous molecular friction, low heat conductivity, and other factors.

The results obtained with aqueous solutions at atmospheric temperatures cannot be applied, and new tools must be found. It was fortunate that at the time when more attention was being paid to the application of

physical chemistry there was created the Geophysical Laboratory of the Carnegie Institution at Washington. The intimate study of the silicates became part of its proper domain. It at once began to develop the measurement of elevated temperatures with a high degree of accuracy, and to specialize in the most refined methods of microscopic investigation. Upon the use of these instruments of research it developed a structure of facts in the field of silicate chemistry which is unique, and which is a source of pride to American science. Its influence radiates into every field of ceramic technology.

It would be tedious to trace the gradual development of ideas in our field, and it might suffice to outline roughly some of the conceptions which we have reached at the present time.

In dealing with such raw materials as the clays we are realizing that we must concern ourselves more and more with the minute and ultimate structure, and less with the gross structure. We are gradually adopting the methods of the chemistry of colloids through the study of the grain size by means of the ultramicroscope, the absorption phenomena, kataphoresis, the determination of the hydrogen ion potential, electrical conductivity, the measurement of plastic and viscous flow, and other measurable factors. It would not be at all surprising if through such work we were enabled to bring about decided changes in the structure of certain of our clays, as for instance in the conversion of the partially set colloids of the carboniferous fire clays to plastic bonding materials, and in destroying the excessively colloid nature of our secondary plastic kaolins.

In the study of the dried and fired materials we are already at work in correlating all the physical properties, such as resistance to compression, tension, and transverse stress, the modulus of elasticity, density, porosity, volume changes, thermal expansion, thermal conductivity, electrical conductivity, etc. It is now generally realized that the minute structure of a silicate mixture is far less dependent upon the initial mineral composition than we thought, and more and more upon the heat treatment it has received. We know that porosity and volume changes are but rough criteria of the molecular changes, and that we must rely upon microscopic examination and the fixing of some function such as the relation between time-temperature and true density, or between time-temperature and thermal expansion. The determination of isolated constants will not yield the information we must have. The rapid extension of the application of the X-ray spectra which have been used in several ceramic problems promises to be a powerful aid in the identification of crystalline structures which develop upon heating, as for instance, to tracing the growth of mullite in porcelain. It is quite possible that such methods may assist in the production of the ideal electrical insulator for our high tension lines.

What has been said of the study of the fundamental properties of clay products applies also to glass and enamels for which we have available in addition a powerful and searching tool in the application of optical methods.

Portland cement has probably received the most thorough microscopic study of all the silicate products, and we know more about its structure; but much remains yet to be done in elucidating the hydration process and in examining the colloidal products which it yields.

Common to all of these industries is the study of the combustion processes, and the problems of uniform heat distribution. While we have accomplished much in this field a great deal remains to be done, particularly as regards the vital question of heat transfer and heat distribution.

This rough outline of the status of our knowledge pertaining to the technology of the silicates has been attempted since it is part and parcel of the subject of ceramic education. The latter, as is true of all other fields of technical endeavor, is in a state of constant flux and growth. This means necessarily that ceramic education should be in the hands of men who are sensitive to this progress, and are able to keep pace with it.

In this connection there is to be voiced the regret that with all of the activity which has prevailed in this field, there is available not a single text book which could be used to replace, at least in part, the lecture system by which the subject of ceramics is taught. This is a most unsatisfactory state of affairs since it places upon the teacher the burdensome and risky task of selecting from the mass of old and new data those fundamental facts which he considers to be the most vital. It cannot be denied that this is a reflection upon the technical workers in this field.

In this country we have provided for the collegiate training in ceramics, while in Europe the trade school has received more attention. We have made no serious effort to provide for those of the industrial workers who aspire to better things, but cannot do so by force of circumstances. We provide commissioned officers, but no sergeants and corporals. A good army needs both. There remains the question as to how this problem can be solved, and whether the university is justified in undertaking extension work.

Finally, we must not neglect to make mention of a part of the system of ceramic education represented by the research activities of the Federal Bureau, the Bureau of Standards, and the Bureau of Mines, which have done much to enrich the store of our knowledge, and undoubtedly will contribute much more in the future. They have played a unique and important part in the development of the industries, and have made a distinct place for themselves in the making of ceramic literature, and hence in education.

THE FUTURE OF CERAMIC EDUCATION[1]

By E. W. Tillotson[2]

It is fitting that the subject of ceramic education be discussed at meetings of a great ceramic technical society, and it is particularly appropriate that a symposium on the subject be held at this University on the thirtieth anniversary of the inaugural of ceramic instruction. For here has been established a department of ceramic engineering from which graduates have gone forth to become leaders in industry. It is clear, however, that any individual or institution in a position of leadership, cannot expect to maintain the advantage without continual effort for betterment. A convocation like the present one is an indication of the desire to train men even more satisfactorily for the growing needs of the ceramic industry, and represents real progress in education.

During these thirty years there has been created a new professional group, ceramic engineers, a uniquely American profession. This new group has more than justified the effort extended in its development, for the ceramic industry is one of the few really basic branches of manufacture in modern civilization. All industries, large and small, depend on some ceramic material for their very existence. Refractories, glass and ceramic materials of construction are essential in engineering. Many of these dependent industries have resulted directly from the developments of science, and probably all have benefited from scientific advancements. It is therefore important that the parent of all industries should bring its own science to the highest possible development, and should train an ever-increasing number of men in its technology, not only for the benefit of itself, but also of those other industries which employ ceramic products.

The requirements of industry for trained men in ceramics are not being supplied. Eleven American schools are doing useful work in ceramic education, but the field is so broad and the opportunities so varied that the need for still more ceramists is growing constantly. If it be assumed that about four hundred graduates in ceramic engineering are now engaged in the industry, it is believed that an additional eight hundred ceramic engineers would not satisfy the country's existing need for ceramic technologists. Men trained in ceramic technology are required in the laboratory for plant control, in the factory as operatives, in the business as executives and as technical salesmen, and in developmental work. This statement applies not only to those industries in which ceramic products are being manufactured, but also largely to those industries in which

[1] An address delivered at Ohio State University, Columbus, Ohio, on the Occasion of the Thirtieth Anniversary of the Founding of Collegiate Training in Ceramics, February 16, 1925.

[2] Assistant Director, Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.

ceramic products are used. For example, altogether too few of even the large users of fire brick, or of special refractories, have the ceramic engineer as a part of their organization. A pertinent illustration has been called to my attention recently: A copper-smelting company, which, for lack of expert ceramic knowledge within its organization, suffered constant and inexcusable loss. Similar instances in many other industries could be given, but the emphasis is upon the point that ceramic education extends beyond the production of ceramic materials and embraces as well the use of them.

The opportunities for men trained in ceramics indicate then the desirability of attracting a greater number of promising students and encouraging them to specialize in ceramic engineering. This result can be accomplished mainly through suitable and systematic publicity by the schools themselves as well as by the AMERICAN CERAMIC SOCIETY. Literature describing the fields of ceramics and setting forth the accomplishments of ceramic engineers and the opportunities for further achievement could be published and placed with professional advantage in the hands of prospective students.

It is not the purpose of this discourse to consider specific courses of instruction for the ceramic engineer. These courses can be and should be improved and standardized in so far as possible, and advantage should be taken of all existing agencies. It would be helpful to have direct coöperation with the Society for the Promotion of Engineering Education and to study the experience of the American Institute of Chemical Engineers in its revisory work in chemical engineering education.

In general, it is clear that the scope of these courses should be made more basically broad rather than more specialized, especially during the first two years. The importance cannot be overemphasized of more thorough instruction in chemistry, including organic chemistry as well as geochemistry, mathematics, physics and other fundamental sciences. The value of sound grounding in English and economics should not be overlooked. These essential subjects contain the basic principles of which engineering is the application and are considered to be irreplaceable in the foundation of an engineering education. Indeed, the discussion of clays and of ceramic materials in the light of these sciences constitutes "ceramics," the study of which, employing all the tools of science, is a responsibility of every department of ceramic education. Unless progress in the scientific aspects of a subject is maintained, not only are the efforts of its sponsors in the past nullified, but it fails in possible accomplishment. The saying of a certain ceramic manufacturer that, "In an age of progress, whoever clings to the methods of the past will soon find himself neglected and forgotten," is true of science as a technological practice. The particular courses devised and the methods of presentation, therefore, should be the

result of continued scientific investigations, carried on without the limitation of immediate industrial utility. Thus the importance of the several branches of chemistry and of other sciences can be evaluated and applied according to their weight in the curriculum. Such an atmosphere of research is advantageous not only in attracting prospective students, but also in its reaction on all the students. Only a few will devote themselves to research, but they will be more adequately trained in research method and the others will have a sympathetic understanding of research and its application.

Proficiency in research and in underlying scientific subjects is not, of course, the full purpose of engineering education. It is equally important that the graduate acquire knowledge by personal experience in the industry which he is about to enter. Coöperative training, which has proved of value in other branches of engineering, is equally available in the ceramic field, and its worth cannot be overestimated. Visits of inspection to plants are useful and important, but required employment in the factory during several months of each school year, for which credits would be allowed, should add materially to the fitness of the graduate for his professional career. This type of training is included to a limited extent in the curricula of some of the ceramic schools. It should be encouraged, systematized, and extended in its scope and utilized as an important aid in ceramic education.

In surveying ceramic literature, one is impressed with the lack of adequate treatises by American authors which can serve as text books in ceramic schools. The literature is scattered widely, in periodicals and in institutional and governmental publications. Such a condition cannot exist indefinitely; and while the student should ever be familiar with the original sources of the literature of his subject, the time must come when that literature is inconvenient for class room use. The appearance of carefully prepared treatises on all branches of the American ceramic industry, especially on heavy clay products, refractories, whiteware and porcelain, and glass, would be a welcome addition to technologic literature. It seems that such literature is necessary if ceramic education is to attain its highest efficiency, and if it is to fulfill the purpose of its founders. One is inclined to wonder why, after thirty years of achievement, at least a comprehensive work on the scientific principles of ceramics has not appeared from any American author. The lack of such works may perhaps be regarded as a reflection on the solidarity of ceramic education in this country. Certainly the production of such treatises should receive sympathetic encouragement from the officials of the schools, if the importance of ceramic engineering is understood by them.

A united and sustained plan of publicity giving information concerning the scope and purpose of ceramics and ceramic engineering is an im-

mediate need to prepare for the ceramic education of the future. Such a program should utilize every available means to inform people generally of the relation of the ceramic industries to their every-day experience, of the accomplishments of the ceramic engineer, and of the opportunities for trained technologists. It should not cease until the gospel of ceramics has been carried into every home in the land, so that the high-school student as well as the average citizen will know as much concerning it as he does of other professions. If such a plan can be carried through, there can be little doubt that the desired students will be found, that the demand for engineers trained in ceramic technology will be multiplied, and that ceramics as a science and as a profession will reach the high plane and receive the recognition that the importance of it in our civilization justifies.

ADDRESS OF THE RETIRING PRESIDENT[1]

By R. D. Landrum

It is somewhat of an anachronism that the President of the American Ceramic Society who will preside over this Meeting, celebrating the 30th anniversary of collegiate education in ceramics, did not have the advantage of a course in any of these ceramic schools. His ceramic education, like that of a large proportion of our members, has come from a source not pictured or mentioned by Professor Watts (see p. 112). When this first ceramic school was but three years of age, the American Ceramic Society was created, and in its publications there is available to the whole world a large proportion of today's ceramic knowledge. From these writings and from attending the meetings of the Society, your President and an ever increasing host of others are obtaining a ceramic education. I wish I could make you realize what a tremendous influence the comparatively few ceramic graduates have had through the American Ceramic Society —and the work goes on.

It is indeed a pleasure to stand before you today as president of this wonderful Society and to be able to state that the enlarged activities of the American Ceramic Society are no longer an experiment. They have proved a complete success.

Our having a full time Secretary-Editor, advertising manager, and a business office here at Columbus has been of great advantage to us, and it is especially gratifying that during 1924, we lived well within our income. There is a balance on the right side of the ledger of almost three thousand (3000) dollars.

The *Journal* and the *Bulletin* have been such that we can well be proud.

---

[1] Presented at the Annual Meeting, American Ceramic Society, Columbus, Ohio, Feb. 16, 1925. (General Session.)

Our original papers have been largely quoted in other technical journals, both here and abroad.

Our work in the preparation of Bibliographies is going on. Those on silica refractories and magnesite refractories are completed and distributed.

It is regrettable that our total membership decreased last year. A part of this decrease is healthy. Some of those who dropped their membership on account of the increase in dues, by that very act showed their ineligibility. We do require that each member must be sufficiently interested. The influx of new members, however, should have been greater. It is the earnest belief of your president that our policy this year of not campaigning for new members has been harmful. No enterprise can succeed without a sales department. The membership committee is our sales department. It did not function this year.

One of our aims next year will be to make it impossible for any one interested in the silicate industries not to know what this SOCIETY has to offer them, and that we want them as members.

On the other hand, the business of handling the advertising in the *Journal* merits our enthusiastic praise. The returns from advertising have increased greatly in spite of the fact that we have altogether dispensed with assistance from advertising agencies. The members can help us next year in further increasing our income by indicating to their suppliers the advantage of advertising in the *Journal*.

The team-work of the active workers among the members has been very gratifying, and I must emphasize especially the very efficient work of our Secretary, the Board of Trustees, the Divisional and Sectional officers, many of the committees, and the very efficient workers in the Secretary's office.

We are under obligations, too, to the companies employing our trustees, the committeemen, and workers in our sections and divisions for the time given so graciously for SOCIETY work. We fully appreciate this and thank them.

In this address of mine, I want to outline briefly the developments in the ceramic industries during the past year and to call attention to the individual members of a change that might be made in our general policy to accelerate our accumulation of fundamental data. This work will largely have to be done by men trained for scientific work of the highest type and, at the same time, thoroughly familiar with the problems of each individual industry.

In my address last month "What the Industries Want from the Ceramic Scientist," I tried to define the term "Ceramic Scientist." In groping to differentiate between the Ceramic Scientist and the Ceramic Engineer, I said that the difference was analogous to the difference between the industrial chemist and the chemical engineer. The editor of *Chemical*

& Metallurgical Engineering has just coined the exact word I wanted. He has taken the first part of the word "scientist," one learned in science, and the last part of the word "technologist," meaning one skilled in technology, to make the new word "scientologist."

The ceramic scientologist is the man required for this work.

In most of the discourses on the subject of research, we find the speaker trying to define and distinguish between pure and industrial research. Of late, they have always ended with the statement that it is difficult to say where one leaves off and the other begins. It is the development of this scientologist in industry that has caused this trouble in definition.

We have pictured in the back of our minds the scientist as an absent-minded individual, careless of everything except the small, rather abstract field in which he is working. In fact, in our frankest moods, he was exactly the kind of a person we did not want to be.

To quote from the editorial, "He was considered as a being apart from ordinary mortals, unpractical and visionary."

Even before the war, perhaps largely through that great interpreter, Robert Kennedy Duncan, this idea in our country began to change. Pure scientific research began to find itself in industry. The practical men in the industries began to teach the scientist in the university the finesse of their processes, and the scientist began to teach the industrial man scientific methods and as the editorial mentioned goes on, "Science today is the helpmeet of industry; and the scientist who hopes to 'arrive' must have for his purpose in life the introduction of changes that will speed production, reduce costs and improve quality; he must devise applications and perfect processes for the utilization and conservation of resources and man power; he must benefit industry and, in doing so, benefit humanity.

"This consummation of ideals may not be his immediate objective, but it indicates the purpose of his work. He cannot dissociate himself from the ultimate object, although this must not be allowed to influence actions or deflect the course in the direction of the scientific ideal, the discovery of fact.

"The gap between the laboratory and the plant has narrowed so much of late that a bridge between the two is possible, whereby the scientist can emerge from his seclusion and, seeing the application of his researches, take a scientific interest in production problems."

The ceramic scientologist will be "up to the minute in theoretical knowledge," and skilled in scientific method, but with a true appreciation of the necessity of using the equipment economically available and temperamental labor actually at hand to accomplish his results.

"Sound practice is only theory tempered by compromise."

This bridge that has connected the blaring temple of industry with the quiet chambers of the laboratory and library, has had men passing

over it both ways. Not only has the scientist passed over this bridge to the joy of exerting scientific method in influencing men and compelling machinery and materials to act according to scientific laws; but the man whose undergraduate work has been in this bedlam of noise and profit has also crossed this bridge in a happy and enthusiastic procession of fellow workers to the laboratory and the library.

Just look over the list of members in our own SOCIETY, and see how many of them have no degrees after their name. Come into our Division meetings tomorrow, and hear practical shop talk in the most technical language. Look over the papers published in our *Journal*, and see how many of them ring true with exact knowledge of the industry itself.

The superintendent of one of the plants with which I am connected has a paper tomorrow showing this drift of practical men toward things scientific. His subject is "The Swan Song of the Rule-of-Thumb Enameler."

Look over the classified list of the 15,000 members of the American Chemical Society, and see what a large proportion of them are office and plant executives. Look at the type of journals you will find on the desks of the purchasing agents of our industries. These men are deeply interested in things technical. That is one reason our *Journal* is such a good advertising medium. In the club cars of our transcontinental trains, find how well informed on technical subjects are your fellow travelers. And these men are the very sinews of our industrial life, the managers and the salesmen.

Many are becoming eligible to what our Dr. Arthur D. Little calls the "fifth estate," "composed of those having the simplicity to wonder, the ability to question, the power to generalize, and the capacity to apply."

No wonder the days of secrecy are over. The doers in the plant and laboratory today are speaking the same language. Openmindedness is becoming a part of common sense.

The technical societies and their journals are having much to do with this general give-and-take educational process, and we should be proud indeed of the part the AMERICAN CERAMIC SOCIETY is having in it.

We have united in one common fold the silicate industries, and our responsibility is great. Unlike the other societies—though our field is probably the oldest and although over 80% of this old earth crust is our domain—the fundamental knowledge that we have gathered together is very meager indeed. And this is to be expected of a field as old as ours.

The art of such industries was fairly well developed through generation after generation of artisans long before science was known. These artisans thought, and many of the older ones yet among us believe, this secret knowledge, handed down from father to son, this to be their stock-in-trade.

Their minds were adamant against either imparting it to others or letting a single change slip in.

It is difficult to realize that when Josiah Wedgewood produced the Plymouth vase, Dalton's theory was unknown, and it was thought that phlogiston escaping from the coal fired the ware!

And yet, Mellor says of this versatile man, the inventor of the pyrometer as well as the creator of the Plymouth vase, "Wedgewood's private note-books teem with records of experiments in ceramic chemistry which would be creditable were they published tomorrow."

We must in some way find means to add to this fundamental knowledge of ours. We have advanced far in art and in engineering. It is interesting to note that Dr. W. E. S. Turner's report of his visit to this country last year uses hardly more than a single page to tell of the scientific development of our glass industry in the last four years and fifteen pages to tell of our engineering advancement.

Our achievements in the mechanical processes of glass manufacture are the marvel of the world. Five plants are now making sheet glass by the Fourcault process, and the commercial success of the Ford continuous flow method for making plate glass is astounding. Thanks to our luxury-loving automobilist, practically every manufacturer of plate glass has made or is now making extensive enlargements. The hand-blown window glass industry has almost disappeared. The fireless leer is coming into its own. The glass pot is largely being replaced by continuous tank furnaces. Torpedo shaped furnaces have appeared—eliminating the troubles caused by the molten glass cooling in the corners of the rectangular furnace. Even tumblers and other light ware are being produced in automatic machines. Mr. Brownlee's scheme of super-insulation of furnaces is an interesting development. We are moving toward mechanical perfection.

On the artistic side of the glass industry we are progressing, too. The old heavy cut glass is being replaced by lighter shapes of beauty and color—even Dr. Turner had to admit our esthetic improvement.

Many of the plants are maintaining laboratories, and the results of the work of technically trained men both in these laboratories and in the plants themselves are plainly shown in their products today. But the contributions of these to our general fund of knowledge are bound to be slow. Most of the results obtained in these laboratories are of immediate commercial advantage. It is scarcely to be expected that they will be furnished to competitors.

It is, I believe, the next task of our SOCIETY to arrange some sort of a scheme where more research work of a more or less fundamental nature can be carried on. A scheme that will allow our Divisions to *initiate* as well as *report* research.

In the enameling industry the same thing is true. We have improved greatly the iron base that we use—our cleaning processes, our furnaces. Our plant routine is becoming reduced to order.

There have been many new enameling plants erected during the past year, three very large ones. Probably the most novel installation this year, and one which makes a long step in the history of enameling, is the designing of a continuous plant by Alvin Sherman of Detroit. This plant will enamel the stove parts for the Detroit Vapor Stove Co. in a process that is almost 100% continuous. Ware will pass singly through the various tanks in the cleaning process, through the drier, and be delivered to the dipper for first coat application. The firing is done in a continuous electrical furnace of unique design, a circular furnace some 15 feet in diameter, with a revolving bottom. This bottom is a net-work of nickel chromium points, and on these points is placed the ware to be fired. There are two openings in the furnace, side by side, one for the introduction of the ware, and the other for taking it out. The rest of the process, coating with white enamel, drying and firing, is also continuous. Three of these circular revolving furnaces are used, one for each coat of enamel.

During the last year, much has been done in improving furnaces in the enameling industry. The electrical furnace is gaining headway. Another type of continuous furnace is now in use at Huntington, W. Va., in the plant of the Armstrong Mfg. Co.

There has been quite a development also of electrical door opening devices, lever turn tilting tables, spraying machines, electrical brushing machines, movable dipping tubs, telescopic sieves and speed forks.

My prediction is that the development in this industry over the next five years will be mainly toward complete continuous enameling processes, and the production of the enamel frit in several centers in sufficient quantity so that it can be produced economically with the technical control necessary.

The Enamel Division has taken to itself in a moderate degree, some initiative in planning and carrying through research work, mainly regarding plant and process problems. Just this year they have raised quite a sum for research. A precedent, mind you!

Nineteen hundred twenty-four was a good year in the Refractories Industry. Although no new plants have been built, many improvements have been made in those existing. There is a tendency toward consolidation.

Many mechanical improvements have been made in this industry, too. Machine pressing of both fire clay and non-fire clay refractories has received greater attention. Dressing machines have been developed. An automatic spalling test furnace was constructed and made a success.

Much attention has been given to drying problems. Two new types of drying pallets are interesting, one of enameled iron and the other of plaster of Paris.

The refractories industry has been fortunate in that the Refractories Manufacturers' Association has been entirely "sold" to the necessity for coöperative research.

On account of the boom in the building trades, this last year has been an unprecedentedly good one in those of our industries depending upon these trades. The value of the products in these industries reached a total far exceeding that of any other year; something like five hundred million dollars. The business, too, was profitable in spite of the fact that competition brought prices down to a point where profit seemed impossible. This profit was the result of the gradual shift from hand power to horse power through continuous processes of firing, conveying and drying.

Almost ten thousand million common bricks were produced. And think! They sold at a profit when the Chicago price was $12.00 a thousand. When we consider that by hand labor it costs as much to lay a thousand bricks as it does to lay them down on the job, we begin to realize the part that quantity production and effective processing has done.

There were almost half as many more face brick manufactured last year than there were five years ago. Many paving brick companies have diverted a part of their capacity to making face brick.

Indicative of the alertness of the executives of these Heavy Clay Products Industries, we note with approbation the formation of the Clay Institute. This was, I believe, the result of the definite recognition on the part of these executives that heavy clay products are a highly technical problem. As Francis T. Owens, chairman of the Heavy Clay Products Division says, "The production of heavy clay products is considered by some today just as technical as the manufacture of steel. The fact that this great truth is becoming more and more recognized, means that we are on the threshold of wonderful developments." And remember, it is not long since it was commonly believed that "anybody could make and fire brick."

Our Heavy Clay Products Division should see to it that our SOCIETY gives all the assistance possible. They should see, too, that this Institute joins with us in our Ceramic Institute when this is formed, and thus have the benefit of a general guidance. There is so much to be done that all must avoid duplication of effort.

In the White Ware Industries the tendency is also toward continuous processes. The outstanding development probably being the complete tunnel kiln plant, including bisque, glost and decorating, such as the new

Homer-Laughlin plant. The floor tile has shown rapid growth, and chief among its developments has been the use of conveying systems and more automatic processing. In the electrical porcelain field automatic finishing machines for line insulators were developed. In the manufacture of sanitary ware the further development of the casting method was one of the big features. One plant has developed a continuous conveyor system on which the casting is done. Humidity control plays a very important rôle in this system. The tendency as in other fields has been toward continuous driers. Larger and larger units are being cast in one piece. The increase in the general adoption of tunnel kilns in the whole white ware industry is very gratifying.

Most of us are radio fans; therefore, I know you were pleased, as I have been, to see this year several contributions to the advancement of radio come from our industries: The use of both glass and porcelain for insulating variable condensers. This insulation has changed them from "low loss" to no loss. The glass socket has just been introduced, and most unusual of all, a pottery radio horn which our friend McAfee manufactures and calls "The Auditorium."

The various individual plants in these finer clay industries, of course, are carrying on technical research work, and are very generous in sharing the results of much of this with each other, through the Terra Cotta, and White Ware Divisions of our SOCIETY. Most of this, however, I believe, is in finding the application of truths already discovered to their own particular needs. We must, therefore, arrange some program so that *new truths* can be discovered; and, happily, we have two Divisions to supply the initiative.

How often every single one of us threading our way through experiment after experiment are baffled from the lack of fundamental data. We are groping in the dark. What a very small sum would have to be spent in proportion to other forms of insurance so that in the future more data will be available. Dr. Washburn used the figure in outlining the plans for the refractories research, of 10% of the fire insurance premium now paid by each industry. This seems ridiculously small when we think of the results it could accomplish.

The other day, I read Bruce Barton's article on "Habits" in the last number of *Good Housekeeping*. He speaks of an interview with "a great scientist and inventor" which so beautifully illustrates a point I want to make, that I'll quote him exactly.

"The inventor began his talk in this novel fashion."

"Did you ever read Fabre's book on the Wasp?" he asked. "The hunting wasp is one of the most interesting of the species. It lives its brief summer existence. As fall draws near, it catches two big beetles and paralyzes them with a sharp sure thrust. Just one thrust in precisely

the right spot. No fumbling, no mistakes. Between the two beetles, it deposits its eggs, covers them, and having fulfilled its life work, lies down and dies.

"In the spring, its children are hatched by the warmth of the sun. On either side of them is the food that will carry them through to self support. They eat, grow and fly away. They live their summer lives and in the fall they repeat the story of their parents. A wonderful story it is. A marvelous instinct it is that tells them just what beetles to select; just how to make that unerring thrust. Yet here is the tragedy of it: When the ruins of Pompeii were uncovered, the work of the hunting wasp was found—two beetles stung in precisely the same faultless fashion, laid on their backs in the unvarying way, wound round with the covering which has not changed in the slightest since the world began.

"No improvement in all the ages. No single evidence of thought. Merely blind instinct repeating dutifully the perfections and imperfections of all that have traveled before. "That," said the scientist, "is typical of the great majority of us humans. We perform well enough the necessary functions of life, but there is no thinking in our processes—only instinct. We move in grooves. We are creatures of our yesterdays. Not once in a year do most of us sit down quietly and say to ourselves, 'I am going to think out a new path and pursue it. I am going to see whether there is not some other way to do this thing than the way in which it has always been done.' "

No one can accuse the AMERICAN CERAMIC SOCIETY, as far as we have gone, of "moving in a groove." Some of us were among those that started this SOCIETY with the one idea of injecting into the industry a little faith that science would assist even in brick making. Then the SOCIETY'S scope enlarged to include all clayworking. Then the technical men from *all* the silicate industries were invited to become one with us. We thus changed the definition of the word "Ceramics." Later the annual *Transactions* was changed to a monthly *Journal*, and then the *Bulletin* added. The membership has grown to over two thousand. Seven societies in one—each Division's work being nearly self determining. We have grown vigorously, but not in any way much different from other technical societies.

We do semi-annually have the joy of keeping up friendships with others whose problems are ours, and contribute our bit each year in papers and discussions. Then we go back to our various jobs of making certain that brick, or kitchen utensils or dishes or bottles are fit to bring profit to our employers.

The other societies are doing these same things. Isn't it time we made another move forward?

Let each Division at this very meeting organize to initiate research. Each one of them can take definite steps to find out what can be done.

One Division can best work through the trade association of its industry. With some of the Divisions, the work in *their* trade association is well under way. Get into this work. Let their research program at least have the counsel of your Division.

Some of the Divisions will probably find it necessary to organize in some other way. Let's make a start.

A program of real research will need funds. These can be obtained. Ambrose Swasey, through other societies, has created an Engineering Foundation of half a million dollars for research work in engineering. Other philanthropists can be found. And if they cannot, and if your industry will contribute to "insurance for scientific advancement" one-tenth the amount they pay for fire insurance—great things can be done. But this movement must be organized, and remember in organizing that the fundamental truths which must be searched for by one Division are very probably the same truths needed by every other Division. Let's organize to avoid duplication.

During the war, science developed with extraordinary rapidity, because of the formation of groups of the most highly competent scientists in the world, and because of the creation of effective channels between these groups.

The American Ceramic Society can duplicate this performance in peace times.

Our job this year is to see to it that an individual Research Institute is organized for each industrial group and a general Ceramic Institute to connect them all.

ANALYSIS OF DATA REGARDING CERAMIC EDUCATION[1]

By Arthur S. Watts

1895—1 school—1 teacher—15 students—$2500 salary budget—$5000 equipment and maintenance budget.

1900—2 schools—4 teachers—less than 25 students.

1925—10 schools granting ceramic degrees and 2 schools training ceramic art teachers—41 teachers—$108,500 amount salary budget—$12,760 annual new equipment budget—value of ceramic teaching plants $500,250.

In 1900 there were less than 25 enrolled ceramic students—in 1925 there are 536 enrolled ceramic students.

In 1900 there were no students graduated with ceramic degrees—in 1925 there are 493 graduates. It was not possible to obtain data regarding the occupation of graduates of all the ceramic schools but of 336 graduates reported 4% are in enamel industry, 5% are in the glass industry, 16%

[1] Presented at the Annual Meeting, Columbus, Ohio, Feb. 16, 1925. (General Session.)

are in the heavy clay industry, 12% are in the refractories industry, 8% are in the terra cotta industry, 18% are in the white ware industry, 6% are in research laboratories or teaching, 9% are in unlisted ceramic industries, 14$^1/_2$% are out of ceramics and 7$^1/_2$% are deceased or no record.

In thirty years we have produced less than 500 graduates, have acquired a plant investment of $500,000 and are spending $100,000 per year for teachers. This for an industry with a capital of $1,055,000,000 and an output which has a value of $800,000,000 per year. The fixed investment for the technical growth of the industry represents .05 of 1% of the value of the invested capital and the salary investment for education represents .012 of 1% of the value of annual output.

Survey of Ceramic Departments of the Universities

The Ohio State University

Founded 1895. Promoted by Dr. Edw. Orton, Jr. and Ohio ceramic industries.

Original appropriation from State Legislature: For salaries $2500; for equipment and maintenance for one year $5000.

Value of present teaching plant and equipment—$45,000.

Present sources of maintenance, State appropriation.

Distribution: salaries $10,450, new equipment $1900, maintenance, General University Fund.

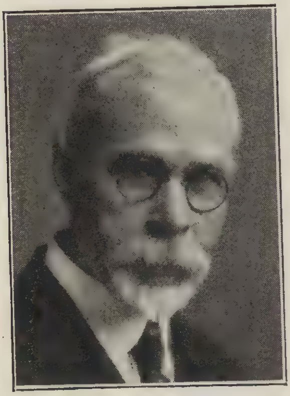
Original personnel—Prof. Edward Orton, Jr.

Arthur S. Watts.

Lord Hall, Ohio State University.

Present personnel—Prof. Arthur S. Watts, Prof. R. C. Sloane, Instructor, Jas. T. Robson, Mechanician, Jno. C. Lysatt, Student Asst. F. C. Westendick.

Registration of students by years—1895-96—15; 1897—10; 1898—12; 1899—14; 1900—17; 1901—26; 1902—33; 1903—30; 1904—35; 1905—32; 1906—45; 1907—63; 1908—54; 1909—54; 1910—61; 1911—44; 1912—34; 1913—42; 1914—49; 1915—65; 1916—63; 1917—49; 1918—39; 1919—40; 1920—36; 1921—37; 1922—60; 1923—73; 1924—96; 1925—101. Total 1329.



Charles F. Binns.

Distribution of graduates: Art 0; Enameled Metals 3; Glass 14; Heavy Clay Products 27; Refractories 22; Terra Cotta 19; White Ware 36; Research Bureaus and Teachers 13; Miscellaneous Ceramics 15; Outside Ceramics 23. Deceased and No Record 21. Total graduates 193.

New York State School of Clay-Working and Ceramics

Founded February, 1900.

Original appropriation by New York State Legislature: $20,000 for establishment, equipment and one year's maintenance.

Value of present teaching plant and equipment—$40,000 as appropriated.

Alfred University.

Present sources of maintenance, State appropriation only.

Distribution: salaries $15,370.00, maintenance $4718.88.

Original personnel—Prof. Chas. F. Binns, Prof. Blanchard.

Present personnel—Prof. Chas. F. Binns, Prof. A. I. Andrews, Prof. A. H. Radasch, Prof. Marian Fosdick, Prof. Catharine Nelson, Instructor Jno. Voorhies.

Registration of students by years—1907—10; 1908—18; 1909—23; 1910—35; 1911—34; 1912—35; 1913—47; 1914—39; 1915—39; 1916—46; 1917—40; 1918—59; 1919—53; 1920—85; 1921—103; 1922—97; 1923—111; 1924—129.

Total graduates 127.

Rutgers College and the State University of New Jersey

Founded 1902. Appropriation from State Legislature. Organized and functioning in 1903.

Original appropriation: $12,000 by State Legislature at the solicitation of a group of prominent clayworkers.

Value of present teaching plant and equipment—$150,000.

Present sources of maintenance, State appropriation.

Present maintenance fund $18,000 per annum. Distribution: Salaries $10,800, supplies and maintenance $5400, new equipment $1800.

Original personnel—Prof. Cullen W. Parmelee.

George H. Brown.

Rutgers College.

Present personnel—G. H. Brown, Professor of Ceramics and Director, W. L. Shearer, Assistant Professor, Malcolm B. Catlin, Instructor, E. J. Vachuska, Instructor.

Registration of students—1925—30.

Distribution of graduates: Data not available.

CULLEN W. PARMELEE.

University of Illinois

Founded 1905. Original promoters, Prof. C. W. Rolfe; Wm. Hammerschmidt; F. W. Butterworth; John Stipes; W. D. Gates; A. W. Gates; Dr. A. L. Converse; D. V. Purington.

Original appropriation by State Legislature: $5000 for 2 years' maintenance.

Value of present teaching plant and equipment—$30,697.28.

Present sources of maintenance, Illinois Legislature.

Distribution: salaries $19,658.40, new equipment $4060.74, maintenance $8652.88.

Ceramics Building, University of Illinois.

Ceramic Engineering Station: Distribution of present maintenance fund: salaries $2478.35, new equipment $864.89, maintenance $1254.90.

Original personnel—Prof. C. W. Rolfe, R. C. Purdy.

Present personnel—C. W. Parmelee, Professor and Head of Dept., R. K. Hursh, Associate Professor, A. E. R. Westman, Research Associate, T. N. McVay, Instructor, E. G. Bourne,'Potter, R. T. Watkins, Assistant, T. J. Wilson, Assistant potter, J. H. Cain, Mechanician.

Northern Illinois Public Utilities Research assistants: E. P. Wright, W. H. Pfeiffer, A. J. Paul.

Registration of students by years: 1905—1; 1906—5; 1907—17; 1908—17; 1909—16; 1910—28; 1911—47; 1912—71; 1913—80; 1914—75; 1915—65; 1916—42; 1917—23; 1918—22; 1919—47; 1920—40; 1921—72; 1922—66; 1923—82; 1924—89.

Distribution of graduates: Art 0; Enamels 8; Glass 2; Heavy Clay Products 16; Refractories 11; Terra Cotta 6; White Ware 22; Research Bureaus and Teachers 7; Miscellaneous Ceramics 13; Outside Ceramics 24; Deceased 5. Total graduates 114.

Iowa State College

Founded 1906 by the Iowa Clay Products Manufacturers Association.
Original appropriation by State Legislature.
Value of present teaching plant and equipment—$31,550.

Iowa State College.

Present sources of maintenance, State appropriation.

Distribution: salaries $11,800, new equipment $500 each year.

Paul E. Cox.

Original personnel—Prof. Samuel Byer, Prof. Ira Williams.

Present personnel—Associate Prof. Paul E. Cox, Asst. Prof. D. A. Moulton, Instructor, Mary L. Yancey.

Registration of students by years: 1910–1911—11; 1911–1912—6; 1912–1913—6; 1913–1914—4; 1914–1915—4; 1915–1916—9; 1916–1917—7; 1917–1918—6; 1918–1919—5; 1919–1920—3; 1920–1921—3; 1921–1922—6; 1922–1923—8; 1923–1924—20; 1924–1925—35.

Distribution of graduates: Art 0; Enamels 3; Glass 0; Heavy Clay Products 7; Refractories 3; Terra Cotta 0; White Ware 1; Teachers 1; Miscellaneous Ceramics 2; Outside Ceramics 2. Total graduates 19.

University of North Dakota

Founded 1910. Established by and under direction of Dean E. J. Babcock, College of Engineering.

University of North Dakota.

Original appropriation by State.

Value of present teaching plant and equipment—$20,000.

Present sources of maintenance, State appropriation.

Original personnel—E. J. Babcock, Margaret K. Cable.

Present personnel—E. J. Babcock, Dean College of Engineering, Margaret K. Cable, Assistant Professor.

Registration of students by years—About 60 per year.

No degrees given.

MARGARET K. CABLE.

University of Washington

Founded 1918. Original promoters, Dr. D. A. Lyon, U. S. Bureau of Mines and Dean Milnor Roberts, University of Washington.

Original appropriation from current University funds.

Value of present teaching plant and equipment—$58,000.

Present sources of maintenance, annual appropriation by State plus U. S. Bureau of Mines Research fund. Distribution: salaries $4000, new equipment and maintenance $3000.

University of Washington.

Hewitt Wilson.

Original personnel—Ira A. Williams.

Present personnel—Hewitt Wilson, Professor, J. R. Gedvetz.

Registration of students by years—2 graduate students, 2 seniors, 2 juniors, 2 special, 4 electives.

Distribution of Graduates: Art 0; Enamels 0; Glass 0; Heavy Clay Products 2; Refractories 2; Terra Cotta 2; White Ware 0; Research Bureaus and Teachers 0; Miscellaneous Ceramics 1; Outside Ceramics 0; Total graduates 7.

University of Saskatchewan

Founded 1921 by the University in conjunction with the Provincial Department of Industries.

Original appropriation—Provincial grant for salary and equipment.

Value of present teaching plant and equipment—$30,000.

Present sources of maintenance $6000 from University for salaries, $1500 for laboratory expenses and a labor fund.

Original personnel—Prof. W. G. Worcester.

University of Saskatchewan.

Present personnel—Prof. Worcester, laboratory Assistant W. H. Phipps.

Registration of students—1st year ?; 2nd year 6; 3rd year none; 4th year none.

Distribution of graduates: Refractories 1; Heavy Clay Products 1; Total graduates 2.

WOLSLEY G. WORCESTER.

Georgia School of Technology

Founded Feb. 1, 1924. Promoters, Dr. M. L. Brittain, Central of Georgia Railway; B. Mifflin Hood Brick Co.

Original appropriation $30,000 donation for building, etc., by the ceramic industries

Georgia School of Technology.

of Georgia and $10,000 annual appropriation by the State.

ARTHUR V. HENRY.

Value of present teaching plant and equipment—$40,000.

Present sources of maintenance, State appropriation of $10,000 per year. Distribution: salaries $4200, new equipment $2800, maintenance $3000.

Original personnel—Dr. A. V. Henry.

Present personnel—Dr. A. V. Henry, Mrs. J. B. Hosmer.

Registration of students by years—Sophomore only represented—4.

The Pennsylvania State College

Founded 1922 by Board of Trustees.

Original appropriation was by State Legislature—$5235.

Joseph B. Shaw.

Value of present teaching plant and equipment—$10,000.

Present sources of maintenance, State appropriation.

Distribution: Salaries $4000, new equipment $700, maintenance $535.

Original personnel—Prof. Joseph B. Shaw.

Present personnel—Prof. Joseph B. Shaw.

Registration of students by years: 1 Junior, 6 Sophomores, 4 Freshmen—Total 11.

Pennsylvania State College.

Newcomb College School of Art

Pottery, molding and decoration started in 1896 by Mrs. Josephine Newcomb, Dr. B. Dixon, E. Woodward.

Original appropriation was donation by Mrs. Newcomb.

Value of present teaching plant and equipment—$25,000.

Present sources of maintenance, sale of pottery $12,000, school fund for instruction $2500.

Original personnel—Ellsworth Woodward, Mary G. Sheerer, Joseph Meyer.

Present personnel—Ellsworth Woodward, Mary G. Sheerer, Joseph Meyer, Vincent Axford, Chemist.

Registration of students by years—1923–24, 51 students.

North Carolina State College

Authorized by Legislature January 1923. Organized September 1924. Promoter, Dr. W. C. Riddick, Dean of Engineering.

Original appropriation by Legislature, $25,000.

Value of present teaching plant and equipment—under construction.

Original personnel—Prof. A. F. Greaves-Walker, Head of Dept., K. W. Reece, Student Assistant.

Present personnel—A. F. Greaves-Walker, Head of Dept., K. W. Reece, Student Assistant.

Registration of students by years—4 Freshmen, 2 Sophomores, 1 Junior, 1 Senior, 30 Short Course Students, 42 Correspondence Students for College Credit.

Arthur F. Greaves-Walker, North Carolina State College.

Page Hall, Mechanical Engineering and Ceramics Building at North Carolina State College, Raleigh, N. C.

THREE GREATEST ACHIEVEMENTS DURING THE PAST THIRTY YEARS

We all recognize that the progress in the field of ceramics during the past thirty years far exceeds that of any similar period in its history but unless some inventory is taken it is doubtful if many of us will fully realize what wonderful strides have been made.

The enormous field included by the ceramic industry makes it practically impossible for any single individual to make a fair and unbiased choice of the three chief attainments of the industry and it seemed wise therefore to solicit opinions from recognized leaders of the various ceramic groups and by analysis of the data presented arrive at a decision.

The Chairman of each Division of the American Ceramic Society was therefore requested to indicate what he considered the three most important achievements in his particular field of ceramics. The replies are listed below in brief form. A survey of the data brings us no nearer our objective since each field has attainments peculiarly its own.

It would be unfair to make any classification and hence none will be attempted.

Terra Cotta Industry

1—The tunnel kiln which gives a more uniform product and shortens manufacturing time.

2—The introduction of color and enamel work.

3—The rust proof anchor and the expansion joint.

W. D. Gates, *Chairman*, Terra Cotta Division.

Ceramic Art

1—Improvement in public taste in household ceramics due to trained supervisors of art in public schools and to art school education.

2—More coöperation between the technician in the factory and the artist in the studio.

3—Recognition by schools and colleges of the educational value of the use of clay.

Mary G. Sheerer, *Chairman*, Art Division.

Metal Enamel Industry

1—Development of wet process enameling of cast iron both over ground coat and as single coat enamels.

2—Improvement in types of furnaces in all branches of the enamel industry.

3—Extension of the uses of enamels both for utility and decorative purposes.

R. R. Danielson, *Chairman*, Enamel Division.

Glass Industry

1—Introduction of scientific chemical and physical control and research.

2—Improved devices in the application of fuels for gas producers, tank furnaces and muffle leers.

3—Development of machines to replace hand labor in glassware manufacture.

G. E. Barton, *Chairman*, Glass Division.

Heavy Clay Industry

1—Improvement in quality and saving in fuel due to the publication of "Effect of Heat on Clay."

2—Development and utilization of fire-proofing.

3—Recognition of the heavy clay industry as a technical industry comparable to the manufacture of steel, etc.

Francis T. Owens, *Chairman*, Heavy Clay Products Division.

Refractory Industry

1—Development of silica refractories making possible the modern by-product coke oven, open hearth furnace, electric furnace, etc.

2—Development of artificial super-refractories as silicon-carbide and fused alumina.

3—Scientific control applied to refractory manufacture.

Fred A. Harvey, *Chairman*, Refractory Division.

White Ware Industry

1—Introduction of scientific methods of measurements and reasoning.

2—Increased knowledge and control of pyrochemical and pyrophysical phenomena.

3—Knowledge of the mineral structure of bodies and of the properties and functions of the mineral constituents produced during firing.

F. H. Riddle, *Chairman*, White Ware Division.

ACTIVITIES OF THE SOCIETY

The 1925 Annual Meeting

The 1925 Annual Meeting is now history. By unanimous opinion of those attending it was a great success. Cordiality, earnestness, and large expectations for the future characterized the frame of mind of each delegate. Although they were convened three miles distant from the hotels, the sessions started promptly at 10 A.M. and at 2 P.M. with good attendance.

The registration totaled over 900. Subtracting duplicates, ladies, and students the roster shows 857 attending. The banquet was attended by 532. The exhibits were larger and more extensive than at any previous meeting of the SOCIETY.

Gratifying are the statistics of this 1925 Annual Meeting but of more importance are two outstanding inspirational facts. (1) The past four annual meetings have reflected increasingly the soundness of the principle of decentralized activities and responsibilities under the activating influence of a central office. To hold meetings of seven Divisions simultaneously, each arranged and managed by its own officers, the whole being harmonious in every respect, is a realization of an idea which many had thought wholly impractical. This 1925 Annual Meeting should be recognized as fully justifying continued collaboration of the several industrial groups on this program. (2) The second pleasing fact regarding this Meeting is found in the following analysis of the program participants:

Authors from	Number	Per cent
Ceramic Schools	22	13.4
Bureaus	21	12.8
Institutes, Associations and Users	16	9.8
Industrial	87	53.0
	164	100.00

In the early years the bulk of the program was furnished by the schools and the bureaus. That more than 50% of the program consisted this year (as did the 1924 program) of contributions from men employed in industrial plants is worthy of careful deductive consideration. It reveals a situation that is very promising for the future of ceramics on this continent.

Columbus hotels proved adequate both in capacity and cordiality. The possibility of successfully holding meetings away from the hotels was proven.

Exhibits

The Ohio Ceramic Industries Association collaborated with the Ohio Archaeological and Historical Society in an exhibit of the ceramic wares produced in Ohio. Though not complete, this exhibit was excellent. A few views of it are here shown. The following firms exhibited:

The American Bottle Co., Toledo, Ohio; American Encaustic Tiling Co., Zanesville, Ohio; The Atlas China Co., Niles, Ohio; The Bellaire Enamel Co., Bellaire, Ohio; The Cambridge Glass Co., Cambridge, Ohio; Cambridge Sanitary Mfg. Co., Cambridge, Ohio; The Colonial Insulator Co., Akron, Ohio; Columbus Clay Mfg. Co., Black Lick, Ohio; The Crooksville China Co., Crooksville, Ohio; The Estate Stove Co., Hamilton, Ohio; The Evans Pipe Co., Uhrichsville, Ohio; The Federal Clay Products Co., Mineral City, Ohio; The Federal Glass Co., Columbus, Ohio; Fraunfelter China Co., Zanesville, Ohio; E. Houghton & Co., Dalton, Ohio; The Iron Clay Co., Columbus, Ohio; Maurice A. Knight Co., Akron, Ohio; The Massillon Refractories Co., Massillon, Ohio; The Mogadore Insulator Co., Mogadore, Ohio; Montgomery Porcelain Products Co., Franklin, Ohio; The Ohio Clay Co., Cleveland, Ohio; Ohio Insulator Co., Barberton, Ohio; The Pfaudler Co., Elyria, Ohio; The Pope-Gosser China Co., Coshocton, Ohio; The Pyro Clay Products Co., Oak Hill, Ohio; Rookwood Pottery Co., Cincinnati,

Ohio; Rush Creek Clay Co., Junction City, Ohio; The Sebring Pottery Co., Sebring, Ohio; A. A. Simonds-Dayton Co., Dayton, Ohio; The Standard Pyrometric Cone Co., Columbus, Ohio; The Stark Brick Co., Canton, Ohio; The Straitsville Impervious Brick Co., New Straitsville, Ohio; Vitrolite Co., Parkersburg, W. Va., S. A. Weller Pottery Co., Zanesville, Ohio.

The equipment and materials concerns exhibiting in Lord Hall were:

The Von Gerichten Art Glass Co., Columbus, Ohio.

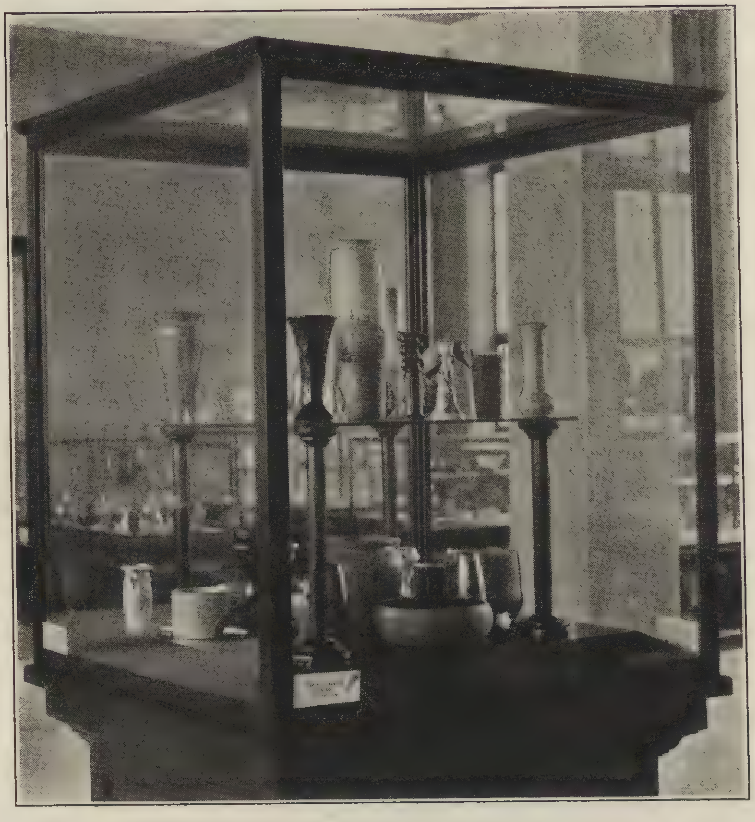
Armstrong Cork & Insulation Co., American Rolling Mill Co., Brown Instrument Co., Buckeye Clay Pot Co., Crescent Brick Co., Celite Products Co., Carrier Engineering Co., Eagle-Picher Lead Co., Chas. Engelhard, Inc., Genesee Feldspar Co., Heath Unit Tile Co., O. Hommel Co., Kauffman-Lattimer Co., Leeds & Northrup Co., Macleod Company, Massillon Refractories Co., Manufacturers Equipment Co., Newark Wire Cloth Co., Ohio Hydrate & Supply Co., Orville Simpson Co., Potters Supply Co., Russell Engineering Co., Roessler & Hasslacher Chem. Co., W. W. Stanley Co., Thwing Instrument Co., W. S. Tyler Co., Titanium Alloy Mfg. Co., Wilson-Maeulen Co., The Wahl Co., Crescent Refractories Co., Hy-grade Manganese Co., McLanahan-Watkins Co.

These exhibits are conducted at actual operating cost to the exhibitor. They are not commercial enterprises. They are presented because of their educational value.

Rookwood Pottery.

The following schools were represented in school exhibits held in Lord Hall. It is regrettable that a view of the North Dakota School exhibit is the only one available to show the character of these school exhibits.

Rutgers College, Georgia Institute of Technology, University of Illinois, Iowa State College, New York State School of Ceramics, Pennsylvania State College, University of North Dakota, Ohio State University, University sity of Washington, University of Saskatchewan, Newcomb School of Art, Winnipeg School of Pottery, Lewis Institute.



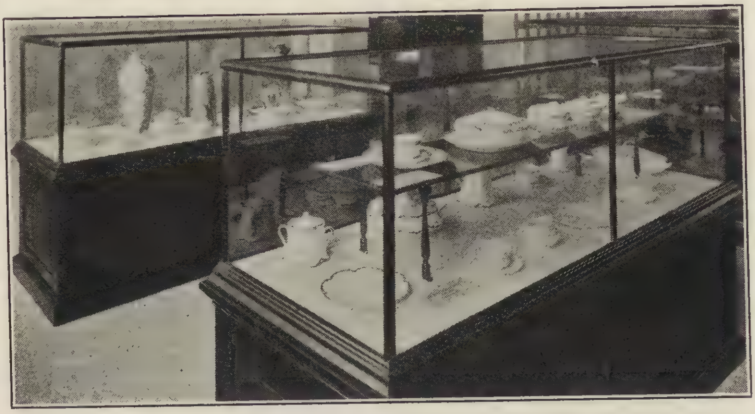
S. A. Weller Pottery Co., Zanesville, Ohio.

General View of Exhibit.

The Federal Glass Co., Columbus, Ohio.

The Sebring Pottery Co., Sebring, Ohio.

One Corner of the Brick Exhibit.



The Pope Gosser China Co., Coshocton, Ohio.

The Cambridge Glass Co., Cambridge Ohio.

The Von Gerichten Art Glass Co., Columbus, Ohio.

The Fraunfelter China Co., Zanesville, Ohio.

The Fraunfelter China Co., Zanesville, Ohio.

The Federal Glass Co., Columbus, Ohio.

American Encaustic Tiling Co., Zanesville, Ohio.

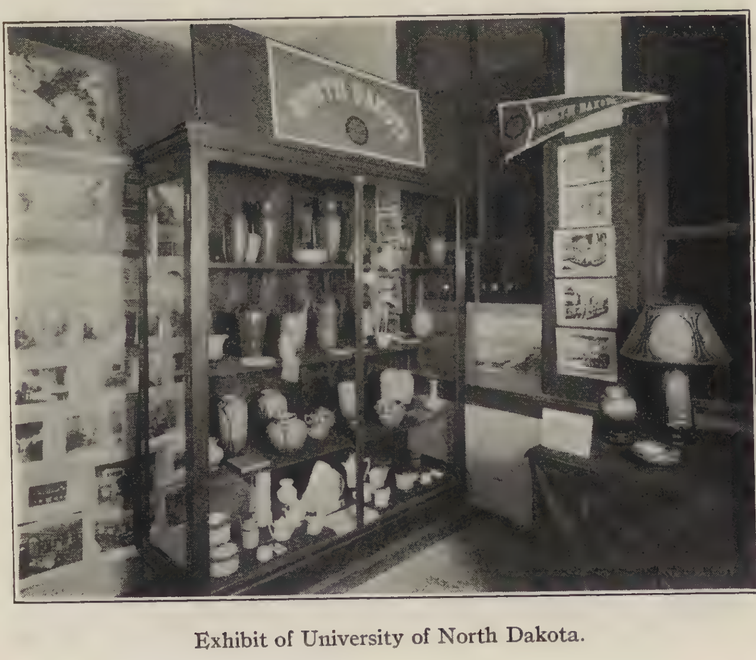
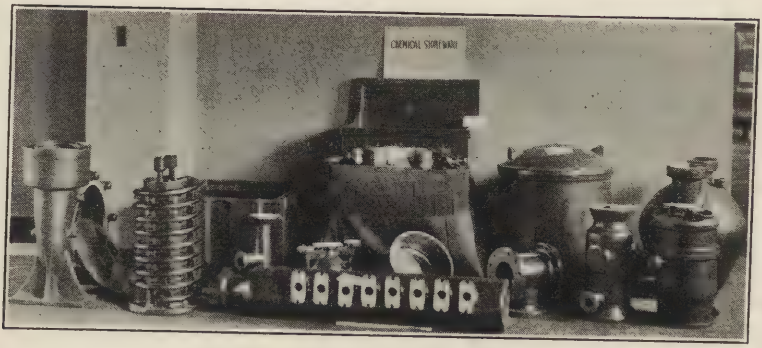
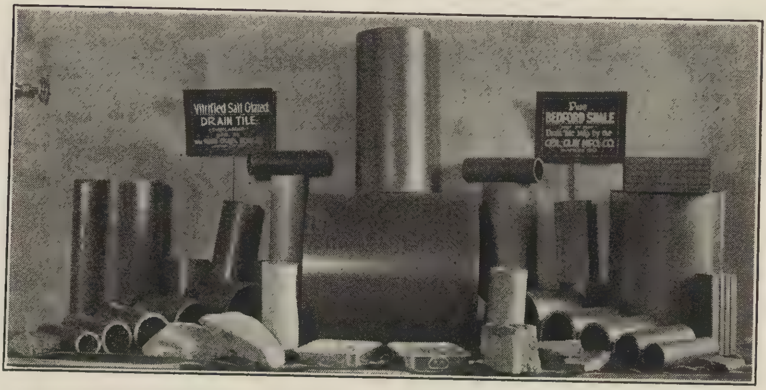


Exhibit of University of North Dakota.



Maurice A. Knight, Akron, Ohio.



Rush Creek Clay Co., Junction City, Ohio.
Columbus Clay Mfg. Co., Black Lick, Ohio.

The Anniversary Lesson The 1925 Annual Meeting was in celebration of the Thirtieth Anniversary of the founding of the world's first collegiate ceramic school. The Ohio State University had invited all ceramic groups to meet on its campus for this purpose and a very informing program was given. The importance of collegiate training in ceramics as shown by the results realized was very strongly set forth. The only phase lacking was a conference on how the universities can best meet the present-day requirements.

Dr. Tillotson gave several important recommendations and it should be apparent that with the facts and inventions made and recorded during the past thirty years the college curriculum possibly should be revised.

That the curriculum devised by Prof. Orton was the very best for those early years there can be no questioning. It was sound in every respect and met the most urgent needs. What seems to be needed today is the directing of our studies more on ceramic products and means of their production to standards, and less on the materials and mixtures.

The school graduates whose instruction ranged from the fundamentals to a finished product would have a vision and a direction in their thinking that is very much needed; indeed this is what makes the shop trained student a superior factory director. Natu-

rally, in such a curriculum of four years' duration equal emphasis cannot be given to all things with which a factory operating ceramist must be familiar hence the present day curriculum should take into consideration the large fund of information which has been written into our literature during the past thirty years and which is available to him who is trained to read and which need not be repeated.

There can be no knowing of the essentials of a satisfactory product without studying the product and the essentials to its production. This should have a large place in our present day school curriculum. An analysis of the Division programs at this Meeting and of the problems now being investigated by the Bureaus and Mellon Institute would reveal the things which should be emphasized in a ceramic school curriculum.

Greetings from England The following congratulatory note from J. W. Mellor, of the Ceramic Society, England, was received during the meeting:

"I beg to take the opportunity of sending our hearty congratulations to you on the celebration of the Thirtieth Anniversary of the founding of your school of ceramics. The valuable work which has been done there in the past under Prof. Orton has won for it a proud place in the evolution of this industry as an art and as a science."

Our Next Meetings (1) The Summer Meeting will be in Canada probably early in July. (2) Our Fall Meeting will be in New York City in connection with the Chemical Exposition. (3) Our 1926 Annual Meeting will be in Atlanta, Ga., early in February.

Atlanta is a night's ride from St. Louis, Chicago, Detroit, Buffalo, and Pit sburgh. It is directly south from Columbus. It is not as far off the geographic center of the ceramic industries as is New York City. Its location and especially the ceramic things they have to show and the cordiality of the invitations extended makes the 1926 Annual Meeting in Atlanta very attractive.

1925-26 Program The Board of Trustees provided for additional editorial assistance to allow the General Secretary more time to work with the committees. The standing committees are planning more actively this year. A special half-day at the next meeting will be devoted to committee assemblies and reports.

A more thorough program of collaboration with other societies and associations is expected this year and especially with the ceramic trade associations. President Landrum dwelt upon this in his presidential address and his recommendations will be followed.

The programs of all of the Divisions suffered from a surfeit of papers and discussions. This gave rise to several recommendations: (1) Closer adherence to the rules covering time limits and reparticipation in the discussion; (2) preprinting of the papers and presenting of them at the meeting only in abstract; (3) providing for technical sessions at the midyear meetings; (4) creating additional Divisions of (*a*) Ceramic Science, (*b*) Fuels and Furnaces and (*c*) Equipment and Materials. Time should be provided by each of the Divisions for committee reports and dinner meetings. These recommendations will be considered and a workable policy evolved by the Division officers.

The 1925-26 Budget The committee recommends the following budget for 1925-26:

Journal		$16,000.00
Reprints		1,000.00
Salaries:		
Secretary	$5000.00	
Asst. Secy	1800.00	
Asst. Editor	2000.00	
Assistant	1200.00	
Extra	1300.00	11,300.00

Traveling	1,000.00
Office Expense	4,000.00
Meeting	1,500.00
Committees	300.00
Divisions	1,000.00
Miscellaneous	500.00
Contingent Fund for President	800.00
Editorial Assistance	2,500.00
	$39,900.00

(Signed) A. F. GREAVES-WALKER, *Chairman.*

Passed by Board of Trustees February 19, 1925.

THE 1925 ANNUAL MEETING PROCLAIMED A HUGE SUCCESS

The General Secretary of the SOCIETY would not be human if he were not gratified in the extreme with the many, many complimentary words spoken and written concerning the 1925 Annual Meeting. It was a huge success from standpoint of attendance, management, entertainment and (the most gratifying) in quality of papers and discussions presented. Quoting a letter from a non-member who is high in the councils of three scientific associations and a constant program contributor and attendant of several: "I never attended a better meeting of any organization. You are particularly to be congratulated upon the practical experience of those who joined in discussions as well as the highly developed scientific nature of the papers and discussions. Such a combination does not exist in any other society which I know."

This and many similar congratulatory comments cannot but thrill and encourage, but as the General Secretary I have a confession. I am not and cannot be made to feel responsible for the success of this Meeting notwithstanding the immense pride I feel because of it. To the officers and committeemen of the Divisions belongs every bit of the credit for the technical programs and the conducting of the Division meetings. They solicited the papers and arranged the programs. To Professor Arthur S. Watts belongs the entire credit for the exercises in celebration of the 30th Anniversary of the founding of collegiate education in America. To Professor James T. Robson and his pupils belongs the entire credit for the many conveniences and the inter-Division service during the meetings. To Professor Carl B. Harrop and his staff belongs the credit for that universally enjoyed banquet. To Mrs. A. S. Watts, Mrs. S. R. Scholes, Mrs. R. C. Purdy, Mrs. G. A. Bole and to the wives of the other local ceramists is due the credit for what many of the ladies thought was the most attractive ladies' special entertainments. The ceramic manufacturers of Ohio deserve all of the credit for the cash and the exhibits which added so much to the "pleasure of all." Dr. William C. Mills, Director of the Ohio Archaeological and Historical Society worked untiringly and with success in interest of the exhibit of ceramic products of Ohio and Mr. L. E. Geyer for the splendid exhibit of ceramic equipment and materials. President W. O. Thompson and Dean E. A. Hitchcock of the University gave much personal time and considerable influence in securing many things which added to the comfort and pleasure of their 975 guests. And finally, but not least, much credit is due to the local committees and persons who carried out their assigned tasks making it possible for every attendant to secure comfortable hotel and other accommodations with the least possible worry and confusion.

The credit for the success of the 1925 Annual Meeting is due to a well-rounded and 100% working organization of Division officers and committees, and enthusiastic and

closely collaborating local men and women. The General Secretary merely served in capacity of a switchboard operator or traffic cop to whom was brought only those duties and responsibilities of an information bureau clerk.

NEW MEMBERS RECEIVED DURING ANNUAL MEETING

PERSONAL

J. Guild Carter, 567 E. State St., Trenton, N. J. Salesman, Genesee Feldspar Co.
J. Y. Cheney, Box 1017, Orlando, Fla. General Manager, Orlando Potteries.
F. R. Colvin, Monongahela, Pa. President, Bessemer Brick Co.
William T. Cristman, 844 Hoben St., McKees Rocks, Pa. Superintendent, Federal Enameling & Stamping Co.
Robert E. Elliot, Box 609, St. Johns, Que., Canada. Manager, Canadian Potteries, Ltd.
E. Olney Herman, Box 54, Momence, Ill. Manager, Tiffany Enameled Brick Co.
Thomas Kennedy, 58 High Park Blvd., Toronto, Canada. General Manager, Dominion Sewer Pipe & Clay Co.
Frank A. King, Vitrolite Co., Parkersburg, W. Va. Superintendent.
Levi S. Longenecker, 409 Bessemer Bldg., Pittsburgh, Pa. District Representative, Vitrefrax Co., Refractory Engineer.
George L. McCreery, 523 N. 6th St., Barberton, Ohio. Chemist, Ohio Insulator Co.
Frank R. Mahurin, Box 123, Bessemer, Pa. Superintendent, Plant No. 2, Metropolitan Paving Brick Co.
A. R. Mallon, Wayne Ave., McKees Rocks, Pa. Enameler, Federal Enameling & Stamping Co.
R. M. Onan, 111 N. Canal St., Chicago, Ill.
J. Clair Peck, Ridgway, Pa. Manager, Ridgway Brick Co.
A. Bryce Redman, Millville, N. J. Manager, T. C. Wheaton Co.
Thomas S. Rogers, 120 W. Kinzie St., Chicago, Ill. Manager, Ceramic Department, Innis Speiden & Co.
David L. Rouleau, 24 Miller St., Mt. Clemens, Mich. General Superintendent, Mt. Clemens Pottery Co.
H. R. Straight, Adel, Iowa. President, Adel Clay Products Co.
T. Dwight Tefft, Darlington, Pa. Manager, Darlington Clay Products Co.
Robert A. Thompson, 409 Philip Ave., Detroit, Mich. Enameler, Porcelain Enamel & Mfg. Co.
John Winkler, 11000 Woodstock Ave., Cleveland, Ohio. Enameler, Cleveland Enameling & Mfg. Co.

CORPORATIONS

The Delaware Clay Mfg. Co., Delaware, Ohio. L. L. Denison, President.
Georgia White Brick Co., Gordon, Ga. W. F. Demuth.
Kentucky Construction & Improvement Co., Mayfield, Ky. R. W. Greene, Manager.
Surface Combustion Co., 366–68 Gerard Ave., Bronx, New York City, F. M. Burt.

Membership Workers' Record

	Personal		Personal	Corporations
H. C. Arnold	1	L. W. Manion	2	
R. F. Brenner	1	A. W. Whitford	1	
H. S. McMillan	1	Office	15	4
			—	—
			21	4

NEW MEMBERS RECEIVED FROM JANUARY 15 TO FEBRUARY 15

PERSONAL

Thomas M. Arnold, 59 E. Frambes Ave., Columbus, Ohio. Student.

Donald W. Boddy, Tennessee Furniture Corp., Chattanooga, Tenn. Superintendent, Porcelain Plant.

Horace N. Clark, Johns-Manville Co., Manville, N. J.

John F. Hager, Jr., care of Bruce & Hager, Ashland, Ky.

Henry W. Harrington, 222 Rand Ave., Lexington, Ky. Superintendent, Bybee Pottery Co.

G. R. Hostetler, 2505—11th St., N. W., Canton, Ohio. Secretary and Treasurer, Castalia Lime & Marl Co.

W. J. Hoven, American Stove Co., 4101 Hough Ave., Cleveland, Ohio.

Hilding Johnson, Celite Products Co., Lompoc, Calif. Ceramic chemist.

Robert H. Louden, Anderson, Indiana. Ceramic Engineer, National Tile Co.

William Marshall, Vern Dale—Bushbury Road, Heath Town, Wolverhampton, England.

Richard H. Martin, 51 Nelson Place, Worcester, Mass. Ceramist, Norton Co.

John F. McMahon, 109 E. Water St., Lock Haven, Pa. Ceramic Engineer, Queens Run Refractories Co.

Edward Norman, Vitrefrax Co., 51st & Pacific Blvd., Vernon, Calif. Superintendent.

Frederick H. Opper, Box 348, Savannah, Ga. President, Savannah Kaolin Co. and Gordon Kaolin Co.

Wilber L. Orme, The Cambridge Glass Co., Cambridge, Ohio. Vice-President.

Walter Schulz, National Enameling & Stamping Co., Granite City, Ill. Ceramic chemist.

P. G. Strassmann, Silamit-Werke, Crefeld-Linn, Germany. President, Silamit-Werke.

A. H. Sullivan, 389 Arcade Bldg., St. Louis, Mo.

Victor N. Yingling, 58 King Ave., Columbus, Ohio. Ceramic Engineering Co.

CORPORATION

Sanitary Scale Co., Belvidere, Ill.

Membership Workers' Record

	Personal		Personal	Corporations
M. F. Beecher	1	W. A. Mudge	1	
Chas. F. Binns	1	W. D. Richardson	1	
K. H. Endell	1	R. R. Shively	1	
Robert F. Ferguson	1	H. F. Staley	1	
H. J. Knollman	1	Office	10	1
			—	—
			19	1

LOCAL SECTION MEETINGS

The Baltimore-Washington Section[1]

The third meeting of the 1924–25 season of the Baltimore-Washington Section was thoroughly enjoyed by the largest crowd which has yet attended one of the local meetings. The meeting was held in the rooms of the Old Colony Club, Hotel Emerson, Baltimore, Md., at 7.00 P.M. Saturday, February 7, 1925.

[1] R. R. Fusselbaugh, Secretary.

We were addressed by Henry P. Rodgers of Rodgers and Reitz on "Thermo-Electric Pyrometry and Its Applications." Mr. Rodgers covered his subject in a thoroughly technical manner and his points were so well taken care of that very little discussion followed.

Next in order was a paper by Charles C. Krause of the Consolidated Gas & Electric Light & Power Co. on "The Use of Gas in Industry." We were given a look into the innumerable uses of gas with special emphasis upon the use of gas in enameling. Mr. Krause invited discussion at various times when he felt that those present would be especially interested. Needless to say he was set upon from all sides, but came up with his colors still flying.

The section expressed their appreciation of the knowledge placed before them by these two experts, and it was the consensus of opinion that, in view of the fact there seemed to be no limit to the use of pyrometers and gas, if the next world for some of them should be a hot one, it would be heated by gas and kept under control by recording automatic pyrometers.

It was then decided to hold our next election at the close of the next meeting, which will be held in Washington at 7.00 P.M., Saturday, April 4, 1925. This will allow the new officers time to prepare for their term.

Anyone interested in ceramics who should be in the vicinity of Baltimore or Washington at the time of our next meeting is cordially invited to attend. Communicate with the Secretary.

The Chicago Section[1]

A meeting of the Chicago Section of the American Ceramic Society was held in the Morrison Hotel on Saturday, January 10, 1925.

After lunch the meeting was called to order by Chairman H. C. Beasley. The Chairman of the Nominating Committee, Leo A. Behrendt, recommended the following members for officers during the year 1925.

President, W. V. Knowles
Vice President, Wm. J. Benner
Secretary-Treasurer, Bruce F. Wagner
Chairman Program Committee, A. F. Gorton
Councillor, C. W. Parmelee.

The above members were unanimously elected.

The first thing on the program was a general discussion of the Columbus Meeting and plans were made for the Chicago Section to go to Columbus on a special car. The discussion turned to ways and means of increasing interest and having more frequent meetings of the local chapter.

The following papers were presented:

"An Oil Fired Smelting Furnace," by Robert MacDougall.

"A Bonus System for Foremen," by H. C. Beasley.

There were forty-one members present.

St. Louis Section Meeting[2]

A meeting of the St. Louis Section of the American Ceramic Society was held at the City Club on Tuesday, February 3. Twenty-two members were in attendance.

---

[1] Bruce F. Wagner, Secretary.

[2] L. C. Hewitt, Secretary.

H. W. Brewer, President of the Wallace Pencil Company, presented a discussion on "The Manufacture of Pencils," which was the chief feature of the program.

The following officers were chosen for the coming year:

Chairman, F. E. Bausch
Secretary and Treasurer, L. C. Hewitt
Councillor, C. W. Berry.

The Pacific-Northwest Section[1]

Fifty-five were present at the annual technical meeting of the Pacific-Northwest Clayworkers' Association on the afternoon of Jan. 17 and discussed the following program: A Study of the Puget Sound Glacial Clays and Shales, by T. O. Smith, Department of Ceramic Engineering, University of Washington; Scumming and Efflorescence of Brick Work, by M. E. Reynolds, Department of Ceramic Engineering, University of Washington; The Marketing of Clay Products, by Prof. W. A. Russell, Department of Business Administration, University of Washington; The Insulation of Ceramic Kilns, by E. J. Bartells, of the E. J. Bartells Company, Seattle; Spalling Tests of Local Fire Clay Brick, by Hewitt Wilson, Department of Ceramic Engineering, University of Washington.

Officers elected for 1925 were: Hewitt Wilson, president; Henry Hoffmann, Lake Union Brick and Fireproofing Co. of Seattle, vice-president; Samuel Geijsbeek, secretary and treasurer; E. E. Saunders, American Fire Brick Co. of Spokane, trustee representing refractories; George MacFarlane, Seattle Brick and Tile Co., trustee representing brick and tile; V. E. Piollet, Washington Brick Lime and Sewer Pipe Co., Spokane, trustee representing sewer pipe; A. L. Bennett, Northern Clay Co., Auburn, Wn., trustee representing terra cotta.

The afternoon session at the new Chamber of Commerce Building, Seattle, was followed by a banquet at the new Olympic Hotel. Over 70 ladies and men were present at this meeting. The entertainment consisted of songs by Miss Louise Lohse, daughter of a prominent brick manufacturer in Seattle, songs by the University of Washington quartette; some very clever sleight of hand tricks of misdirection and talks by H. R. Kreitzer, president of the Brick Manufacturers' Association; Mr. F. T. Houlahan, president of the Clayworkers' Association, Dean Milnor Roberts, School of Mines; Dr. Henry Suzzallo, University of Washington and Hewitt Wilson, toastmasters.

The recorded attendance is as follows: F. T. Houlahan, Seattle; A. H. Wethey, Jr., Portland; W. E. Wilson, Salem, Ore.; John H. Corbett, Yakima, Wn.; Willard P. Palin, Tacoma; A. L. Bennett, Auburn, Wn.; E. F. Goodner, Spokane; H. B. McMillen, Seattle; Olaf Olsen, Des Moines, Wn.; L. K. Miller, Seattle; Jess Cooper, Seattle; N. W. L. Brown, Sumas, Wn.; Foster Hidden, Vancouver, Wn.; E. G. Krebs, Tillamook, Ore.; C. A. Houlahan, Seattle; Geo. O. Kribs, Seattle; C. M. Brasfield, Seattle; Willis E. Clark, Seattle; Geo. C. Feller, Longview, Wn.; C. E. Curtis, Seattle; H. Hoffmann, Seattle; D. M. Baird, Chicago; Arthur Houlahan, Seattle; E. K. McQuarrie, Seattle; H. R. Kreitzer, Portland; M. B. Reilly, Portland; V. E. Piollet, Spokane; J. B. Stirrat, Seattle; J. O. Greenway, Spokane; Frank Lohse, Seattle; J. W. Knapp, Mt. Vernon; D. Shaffer, Everett; Burton Shaffer, Mt. Vernon; Blake R. Thompson, Mt. Vernon; E. J. Hutmaker, Seattle; C. S. Engelbrecht, Seattle; T. O. Smith, Seattle; M. E. Reynolds, Seattle; T. E. Nicholson, Seattle; W. J. Howard, Seattle; H. H. Bartells, Bellingham; L. Longiton, Granger, Wn.; E. G. Wulff, Renton, Wn.; Geo. Adderson, Renton;

[1] Combined meeting of the Pacific-Northwest Clayworkers' and Brick Manufacturers' Associations. (Local section of AMERICAN CERAMIC SOCIETY.)

W. E. Lemley, Taylor, Wn.; R. H. Clinton, Seattle; W. A. Steinhauser, Seattle; E. J. Bartells, Seattle; R. A. Swain, Seattle; Hewitt Wilson, Seattle; Samuel Geijsbeek, Seattle; W. A. Russell, Seattle.

The Pittsburgh Section

Thirty-nine members of the Pittsburgh Section of the AMERICAN CERAMIC SOCIETY journeyed to East Liverpool, Ohio, on January 16, where they inspected Plant No. 6 of the Homer-Laughlin China Co. at Newell, W. Va., Plant No. 1 of the Hall China Co. and the Lisbon, Ohio, plant of the R. Thomas and Sons Co.

The members with their president, J. W. Cruikshank, arrived in East Liverpool on an early train and were taken at once to the Newell plant. Special interest was taken in the tunnel kilns which are being operated there.

REPORT OF COMMITTEE ON DATA

Data Which Has Been Compiled

Tensile Strength of Some Metals at Ordinary Temperatures
Mean Specific Heats of Gases
Cubic Expansion of Gases, per Degree Centigrade
Coefficient of Linear Expansion per Degree Centigrade
Weights of Rock and Sand
Coefficients of Linear Expansion per Degree Centigrade
Latent Heats of Fusion—Compounds—Silicates
Specific Gravities and Unit Weights of Solids and Liquids
Batteries, E. m. f. of Standard Cells
Hydrometer Conversion Factors
Work and Energy
  Weight, Force or Pressure, Combined with Areas
  Table of Equiv. Values for Power Expressed in Various English and Metric Units
C. G. S. Units
Conversion Tables, Cubic Measure
Conversion Weight—English
Conversion Table—Weight
Units of Heat
Standard Thermometric Points
Conversion Table, Linear Measure
Conversion Table, Square Measure
Comparison of the Properties of Fused Silica and Hard Porcelain
Specific Heat of Gases (Calories per gram of gas at t°C)
Table of Mean Specific Heats (Calories per gram of gas)
Comparative Composition of Different Fuels (Moisture content when new)
Oxygen and Air Required for Perfect Combustion
Theoretical Maximum Combustion Temperatures
Limits Fuel Analysis—United States
Typical Gas Analyses
Baumé Gravity and Corresponding Specific Gravities, Weights per Gallon and Calorific Power of Oil

Heat of Formation of Aluminates
Reduction Temperatures of Some Refractory Oxides
Decomposition of Carbonates
Decomposition of Sulphides
Heat of Formation of Silicates
Total Heat Contained in Certain Silicates When Melted

Table of Mean Specific Heats—Calories per Gram of Gas
Mean Specific Heats of Gases
Specific Heats of Gases
Specific Heats of the Oxides

Latent Heats of Evaporation
Specific Heats of Aluminates, Titanates, Etc.
Standard Sizes of Clay Products—Brick; Load Bearing Tile; Paving Brick
Properties of Some Selected Domestic Bond Clays

Enamels

Tables of Expansion Values for Compounds and Some Materials
Method of the Calculation of the Coeff. of Expansion of Enamels and Glasses
Table of Compounds and Oxides Used in Enamels with Atomic and Molecular Weights
Method of Calc. of Melted Comp. from Batch Weights
Method of Calc. of Molecular Formulas from Batch Weights
Twelve Typical Enamel Formulas Which Will be Sent You as Soon as Copies Can Be Made. Sheet and Cast Metal Included
Table of Standard Gauges for Sheet Metal
Weight of Enamel per Sq. Ft. of Sheet Steel
List of Heat Resisting Alloys for Burning Tools
List of Acid Resisting Alloys for Pickling Baskets
Suggestions have been made that the following material be covered:
Specific Gravity and Percentage Composition of Acids Used for Pickling; Also a List of Pickling Compounds
Tabulation of the Various Constituents Used in Enamels and Their Effect upon the Physical Properties of the Enamels
Common Faults of Enamels and Their Corrections
Range of Composition of Sheet Iron and Steel and Cast Iron Used for Enameling

Glass

Raw Materials and Their Properties
Coloring Materials

Heavy Clay Products

Mr. Schurecht reports that the collection of data on heavy clay products, including the following—brick of various kinds; strength of brick in masonry; strength of mortar and masonry; salt glazed pipe; drain tile; hollow building tile—is about 90% completed.

Further, that information relating to heavy clay products with respect to flow sheets showing stages of manufacture of several products; (2) short paragraph showing essential differences between stiff mud, soft mud and dry press process; (3) ditto describing properties of materials suited to these several processes; (4) data relating to the ordi-

narily used processes—covering types of apparatus (all materials), capacities, costs, etc., relating to (*a*) blasting; (*b*) excavating; (*c*) loading; (*d*) hauling; (*e*) crushing, grinding; (*f*) screening; (*g*) mixing or pugging; (*h*) shaping—is about 20% completed.

Refractories

See following report:
Members of Committee: L. J. Trostel (*Chairman*); J. T. Robson and J. B. Shaw.

Plan of Work

The ultimate idea is to develop data along the outline suggested by Professor Parmelee in his general letter of Oct. 1, 1923 to the Data Committees of the various divisions of the SOCIETY. The general lines of attack were to be: I, Raw Materials. II, Processes. III, Finished Products.

The program of our Committee for this year has been to try and cover only points I and III, since the points to be investigated are similar. These points include:

1. Definitions
2. Specifications
3. Sources of Supply
4. Analyses
5. Formulas
6. Methods of Testing
7. References in the Literature

This first year's program was divided into three phases, each to be investigated by a member of the committee as follows: (*a*) Acid Refractories, Prof. Shaw; (*b*) Basic Refractories, Prof. Robson; (*c*) Neutral Refractories, Mr. Trostel. The committee will cover point II of the above outline in similar fashion working up a flow sheet of the various processes concerned in refractories manufacture and attempt to collect all pertinent data relating to the processes and product.

Outline of Results

1. *Definitions.* This matter was taken up with Dr. Harvey, Chairman of the Division, and it was decided to leave the actual formulation of the definitions to the Society's Committee on Nomenclature which has been working on the topic for several years. We will then include any definitions of refractories arrived at in our final report. The Committee will also draw upon the definitions arrived at by the A. S. T. M.

2. *Specifications.* Specifications covering the purchase of refractories and refractory materials are existent with probably a dozen large consumers at present as well as the various government departments, such as the Navy, Fleet Corporation and others. A list of such consumers has been compiled and one of the members of the committee will attempt to collect such specifications. The published specifications of the Bureau of Standards and the A. S. T. M. will also be included.

3. *Sources of Supply.* The Society's Committee on Geological Survey is covering this topic for all materials and our committee will keep in touch with them.

4. *Analyses and Formula.* O. A. Hougen of the Chemical Engineering Department of the University of Wisconsin has published a very extensive and comprehensive table in *Chemical and Metallurgical Engineering*, May 12, 1924, covering practically the entire refractory field. This table lists the formula (composition), resistance to basic and acid fluxes, resistance to molten metals, softening and fusion point, deformation under load and coefficient of expansion. Complete references to the literature accompany the table. This, we hope to be permitted to incorporate in the handbook eventually.

5. *Methods of Testing.* The only tests we will be concerned with are those already standard. This will include those suggested by the SOCIETY and the A.S.T.M. and will cover both chemical and physical tests.

6. *References in the Literature.* This is particularly well taken care of in the very excellent bibliographies in existence on magnesite, silica and the one shortly to be issued on clay. One of the members of the committee has started a bibliography covering chrome which will round out the typical refractories.

(Signed) LOUIS J. TROSTEL, *Chairman*

Pottery

Owing to the inability of Mr. Treischel to continue on the committee, Edward Schramm was appointed to fill his place, but owing to some misunderstanding he was not notified until subsequent to January of this year.

Mr. Schramm has been requested to compile data relating to pottery and porcelain, excepting such as may be included under the head of sanitary ware and electrical porcelain.

Mr. Klinefelter has been requested to furnish information regarding the manufacture of types of sanitary ware which might properly be included under the type of white ware, namely, vitreous and earthenware.

Mr. Twells has been requested to compile information relating to the manufacture and properties of electrical porcelain.

Terra Cotta

Mr. Klinefelter has been requested to compile information relating to architectural terra cotta. No reply has been received from him regarding this matter.

Glass

Reference has already been made to the information at hand relating to the manufacture of glass. In addition, A. E. Williams has been requested to furnish the following information:

Definitions and simple classifications of principal types of glass
Ceramic formulas and batch weights of more important types
Graph showing limits of compositions of more important sorts of glasses
Statement regarding the use of Tscheuschmer's formula.

G. B. McCauley, Corning Glass Works, has been requested to furnish information relating to coefficient of thermal expansion: strength, plasticity, etc.

It is recommended that R. K. Hursh be invited to assist in the compilation of data relating to drying and firing.

C. W. PARMELEE, *Chairman*

Supplementary data received from the Chairman of the Enamel Division states that the following tables are now being compiled:

1. A tabulation of various raw materials used in enamels and their effects
2. Common faults of (causes of failure) enamels and their correction
3. Cleaning compounds for sheet iron and steel
4. Tables of specific gravity of acids used for pickling
5. Ranges of compositions of iron and steel for enameling.

R. J. Montgomery of the Sub-committee on Glass has sent data relating to decolorizers, clarifiers, opacifiers, physical properties of glass, types and specific gravities of optical glass of various sorts, and hardness of glass.

NOTES AND NEWS

U. S. GOVERNMENT MASTER SPECIFICATIONS FOR FIRE CLAY BRICK[1]

This specification was officially promulgated by the Federal Specifications Board on January 22, 1925, for the use of the Departments and Independent Establishments of the Government in the purchase of fire clay brick.

The latest date on which the technical and inspection requirements of this specification shall become mandatory for all Departments and Independent Establishments of the Government, is April 22, 1925. They may be put into effect, however, at any earlier date, after promulgation.

Classes

I. Fire clay brick shall be of the following classes: SH 75, H 75, H 57, M 73, H 25, M 7.

For derivation of the class nomenclature used see Section VII of this specification

Material and Workmanship

II. The material covered by this specification is a brick of standard or special shape composed of heat-resistant clay or clays and which has been fired to produce the desired strength and structure. The brick shall be compact, of homogeneous structure, free from checks, cracks, voids or soft centers. All corners shall be sufficiently solid and strong to prevent excessive crumbling or chipping when handled.

General Requirements

III. All brick of the standard 9-inch series shall not vary from specified dimensions more than $1/8''$ in width and thickness, and $3/16''$ in length. For special shapes no dimension specified unless greater variation is allowed by contract, but in no case shall a variation of less than $1/8''$ be specified and they shall be free from such swells, warps, twists, or distortions as shall prevent ready and accurate laying up with a maximum joint of $1/8''$.

Detail Requirements

IV.

Class SH 75

1. The material shall contain not more than 65% total silica, SiO_2.
2. The softening point shall be not less than that of standard pyrometric cone 31 (approximately 1650°C or 3000°F).
3. The material shall withstand 15 quenchings without failure.
4. When specified the brick shall pass the simulated service test.

Class H 75

1. The softening point shall be not less than that of standard pyrometric cone 31 (approximately 1650°C or 3000°F).
2. The material shall withstand 12 quenchings without failure.

Class H 57

1. The softening point shall be not less than that of standard pyrometric cone 31 (approximately 1650°C or 3000°F).

[1] Federal Specifications Board Specifications No. 268.

2. The material shall withstand 5 quenchings without failure.
3. The absorption after reheating shall be not less than 6% nor more than 16%.

CLASS M 73

1. The softening point shall be not less than that of standard pyrometric cone 29 (approximately 1610°C or 2930°F).
2. The refractory shall withstand 2 quenchings without failure.

CLASS H 25

1. Siliceous brick shall contain 70% or more total silica, SiO_2.
2. The softening point shall be not less than that of standard pyrometric cone 28 (approximately 1390°C or 2895°F).
3. The material shall withstand 6 quenchings without failure.
4. The deformation under load shall not exceed 3%.

CLASS M 7

1. Siliceous brick shall contain 70%, or more, total silica, SiO_2.
2. The softening point shall be not less than that of standard pyrometric cone 28 (approximately 1590°C or 2895°F).
3. The material shall withstand 3 quenchings without failure.
4. The deformation under load shall not exceed 4%.

Method of Testing

V. 1. The content of total silica shall be determined by analytical methods described under the A. S. T. M. Standard method, Serial Designation C 18–21.

2. The softening point shall be determined according to the A. S. T. M. Standard Method of Test for Softening Point, Serial Designation C 24–20.

3. The quenching test shall be conducted on standard 9-inch straight brick which have been brought uniformly, under no load, to 1400°C (2552°F) in not less than 5 hours and held for 5 hours, and allowed to cool in the kiln and without induced draft to room temperature.

The quenching is conducted in the following manner: the brick is heated by placing in the door of a suitable furnace which is being held at a temperature of 850°C (1562°F). The heated end of the brick should be flush with the inner face of the furnace and the outer end should be exposed to the free circulation of air.

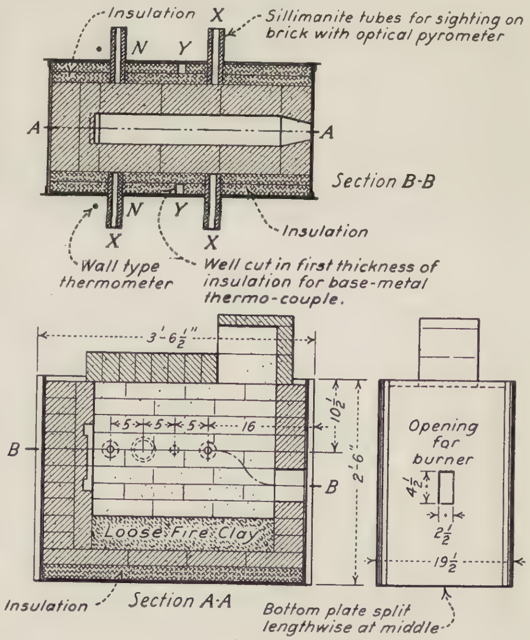


FIG. 1.

At hourly intervals the hot end of the brick is immersed in running water for 3 minutes and to a depth of 4 inches. The brick is then removed, allowed to steam in the air for 5 minutes, and returned to the furnace door. This cycle is repeated until the specimen has failed.

The brick is considered to have failed when the entire plane surface of the heated end has completely spalled away, or when the structure of the brick has become so weakened that the end can be easily removed with the fingers.

The results of any one brand shall be reported as the average of 5 specimens.

4. The absorption shall be determined for brick which have been brought uniformly under no load to 1400°C in not less than 5 hours and held for 5 hours and allowed to cool in the kiln and without induced draft to room temperature.

The test shall be conducted on specimens not less than 100 grams in weight, one specimen to be taken from each of 5 bricks of any one brand and the average result reported.

The per cent absorption shall be determined according to the following formula:

$$\text{Per cent absorption} = \frac{W - D}{D} \cdot 100$$

W = weight of specimen after having been boiled in water for 2 hours and allowed to cool in the water.

D = weight of specimen after having been dried to constant weight at 110°C.

5. The load test shall be conducted according to the A. S. T. M. Standard Method of Test for Heavy Duty Fire Clay Refractory Material under Load at High Temperatures, Serial Designation C 16–20.

6. The simulated service tests shall be conducted in the following manner:

(*a*) Tests are conducted in small oil-fired furnaces, the dimensions and method of construction of which are shown on page 145. For comparative purposes, one side wall of the combustion chamber is built up of brick and cement of approved brands and the other side wall of brick and cement of the samples under examination. Both walls are backed uniformly with 3 inches of insulation. An air atomizing fuel oil burner is used. The flame sweeps the length of the furnace, curves upward and returns to the front, then up the stack from which it escapes horizontally toward the rear of the furnace.

(*b*) The test consists of 2 runs, each of 24 hours duration, at furnace temperatures of 1590°C and 1650°C (approximately 2895°F and 3000°F) respectively.

(*c*) During each run the following temperature determinations are made:

Furnace Temperatures

Temperatures of outer face of brickwork of each side wall at the front and rear of furnace.

(*d*) Furnace temperatures are determined at quarter-hourly intervals with an optical pyrometer sighting on flame through front of furnace above burner.

(*e*) Temperatures of the outer face of the brickwork of each side wall are determined at half-hourly intervals, with an optical pyrometer sighting on the brickwork through sillimanite tubes, the ends of which are placed flush with the wall. The tubes are carefully lagged and plugged to prevent radiation losses.

(*f*) A spalling test is conducted at the conclusion of each run by injecting air at room temperature under forced draft into the furnace immediately after shutting off the oil supply to the burner. The injection is continued for 2 hours.

(*g*) The comparative heat insulating properties together with the relative conditions of the side walls determine whether or not the material under test is acceptable for use in service.

7. The combined results of workmanship, chemical analyses, softening point, and absorption and load tests where required, shall be considered as a suitability test, but (at the discretion of the purchaser) the simulative service test may replace all other tests included in the suitability test.

8. Workmanship and softening point determination shall be considered as a control test.

Marking

VI. In each brick shall be molded the trade name, or the name of the manufacturer, or such a mark as will serve to identify the material.

Additional Information

VII. 1. The consignor shall be notified of the rejection of a shipment based on this specification, unless otherwise specified, within 10 days after receipt of a shipment at the point of destination. If the consignor desires a retest, he shall notify the consignee within 5 days of receipt of said notice.

2. The cones referred to in this specification are manufactured by the Orton Standard Pyrometric Cone Co. and are known as the Orton pyrometric cone.

3. The class nomenclature used in Section 1 of this specification is based on the following scheme devised by Committee C-8 on Refractories, of the American Society for Testing Materials:

Temperature: Indicated by prefixing proper letter to number H = High temp. M = Moderate temp. L = Low temp.		Load unimportant			Load moderate			Load important		
		Abrasion unimportant	Abrasion moderate	Abrasion important	Abrasion unimportant	Abrasion moderate	Abrasion important	Abrasion unimportant	Abrasion moderate	Abrasion important
Slag Action Unimportant	Spalling Unimportant	1	2	3	4	5	6	7	8	9
	Spalling Moderate	10	11	12	13	14	15	16	17	18
	Spalling Important	19	20	21	22	23	24	25	26	27
Slag Action Moderate	Spalling Unimportant	28	29	30	31	32	33	34	35	36
	Spalling Moderate	37	38	39	40	41	42	43	44	45
	Spalling Important	46	47	48	49	50	51	52	53	54
Slag Action Important	Spalling Unimportant	55	56	57	58	59	60	61	62	63
	Spalling Moderate	64	65	66	67	68	69	70	71	72
	Spalling Important	73	74	75	76	77	78	79	80	81

NOTE: Class SH 75 (special high temperature) is so designated because it is mean to apply to especially severe boiler practice.

4. Definition of classes.

CLASS SH 75: Brick of this class are intended for use under the most severe conditions of boiler practice, such as marine boilers used by the Navy and in plant installa-

tions designed to operate at an average rating of not less than 175. Material of this class should have high resistance to slagging, spalling and severe temperatures.

In the United States Navy service brick of Class SH 75 are used in oil-fired boilers operated at greater than 500 per cent rating, and where severe vibrations and rapid changes in temperature occur. In this service the brick are secured by anchor bolts.

Class H 75: Brick of this class are intended for use under conditions such as are encountered in general boiler practice. For this class, resistance to slagging, spalling and high temperature is important.

Class H 57: Brick of this class are intended for use under conditions where resistance to spalling is not of great importance and where resistance to slagging and high temperature is important. In general boiler practice they may be used in the side walls, but, if the refractories used are limited to one brand, material of Class H 75 is recommended.

Class M 73: Brick of this class are intended for use at moderate temperatures such as are encountered in hand-fired boilers operated at average rating not exceeding 125. Resistance to spalling and slagging is important under these conditions of temperature.

Class H 25: This class is intended primarily for brick of siliceous nature and for service in which resistance to slagging and spalling is not of particular importance, but in which the refractory is expected to resist deformation under load at relatively high temperatures.

Brick of Class H 25 are particularly adapted for service under conditions where resistance to deformation under load, with soaking heats at relatively high temperatures, is important, but where there is no marked fluctuation of temperature below approximately 650°C (1202°F).

Note: Brick of Class H 75 which withstand the load test satisfactorily may be included in this class.

Class M 7: This class is intended primarily for brick of siliceous nature, for service at moderate temperatures, and under the conditions where resistance to spalling and slagging is not important, but where resistance to deformation under load is important.

Brick of this class are particularly adapted for service under conditions where resistance to deformation under load, with soaking heats at moderate temperatures, is important, but where there is no marked fluctuation of temperature below approximately 650°C (1202°F).

Note: Brick of Class M 1 which withstand the load test satisfactorily may be included in this class.

General Specifications

VIII. No details specified.

SOCIETY OF GLASS TECHNOLOGY

A meeting of the Society of Glass Technology was held in the University, Birmingham, on Wednesday, January 21, the President, Col. S. C. Halse, in the chair. The initial formal business included a resolution to send a cordial invitation, jointly with the (English) Ceramic Society, to the American Ceramic Society to visit this country in the summer of this year. It was also resolved to invite the Belgian members of the Society of Glass Technology to pay a return visit to this country in May.

The main business of the meeting was a discussion on "The Design of Modern Glass Melting Furnaces." This subject was introduced by two papers, illustrated by lantern slides. The first was: "Some Recent Developments in Furnaces and Gas

Producers for Glass Works" by J. S. Atkinson. The first part of the paper gave information based on more extended experience of the "Stein" recuperative pot furnace. A new design of "Unit" pot furnace was also explained, each unit or section containing two pots. Each section was independently controlled having its own set of recuperator , and gas and air valves, also separate chimney damper. One or two sections could be laid down in the first instance and other sections could be added as required. Turning to tank furnaces, the author described a very interesting design recently installed by T. C. Moorshead at the Charlton Works of Messrs. United Glass Bottle Manufacturers Ltd. The melting tank was shaped somewhat like a torpedo, hence the name "Torpedo" tank. The merits of this furnace were stated to be: (1) By eliminating the corners which the ordinary rectangular furnace had, a more rapid and uniform circulation of the glass was obtained; (2) the construction of the bridge, flared out as it was from the center of the furnace, made it possible to ventilate or cool the side wall and bridge blocks much more efficiently, (3) the effective melting area was not reduced, but the volume of glass in the tank was reduced, giving higher melting efficiency.

Dealing next with continuous leers, Mr. Atkinson described a new design in which very radical changes had been made in the design of the conveyer belt and operating mechanism. The advantages claimed were (1) the high repair cost of the conveyer belts was practically eliminated; (2) stoppages necessitated by repairs to belt and the consequential loss of output were eliminated; (3) alternating current was as suitable as continuous current for the operation of the motor. The first cost of the installation of this new design was about the same as in the case of a leer fitted with Stephens-Adamson type belt.

Referring to gas producers, a description was given of an automatic ash remover which assisted the Chapman agitator working on the top of the fuel bed to maintain a homogeneous fuel bed. A high rate of gasification and a very rich quality of gas resulted. In addition, there were no heavy moving parts, and the ashes were removed continuously. The operation was very simple, and one man could operate from 4 to 6 producers.

The second paper was entitled: "Some Recent Developments in Furnaces and Gas Producers for Glass Works" by Th. Teisen. The author observed that it would be well if glass works would more clearly define their needs and the ideal main lines to be worked on, whether output was to be the deciding factor, or thermal efficiency, life, and so on. In any case the order in which these factors had to be placed must first of all be clearly defined, as that would decide the features of the design. It had to be borne in mind that the use of automatic machinery had called for an increased output which, so long as it was not overdone, would raise the thermal efficiency. Following a discussion of the advantages and defects of the cross flame regenerative glass tank furnace, a comparison of it was made with the open-hearth steel furnace. The author expressed the opinion that in the case of small and medium-sized tanks, a high thermal efficiency might be more easily attained by the use of the recuperative type of furnace, where the width could be relatively small, and the length could be made correspondingly longer, the flame passing toward the working end.

The author exhibited lantern slides showing a proposal for an accessible bridge, which was obtained by giving the tank a wasp shape. Burners might be arranged at the end, and draw-offs on either side of this wasp-shaped bridge. In conclusion, Mr. Teisen proposed the trial of an all steel bridge cooled by water, the molten glass could be made to freeze round it and form a glass bridge. Although there might be some difficulties with the heating up before the glass was founded, he considered that this could be overcome by increasing the amount of cooling water, or it could be protected in other ways. The actual temperature, however, would hardly exceed that of the fire tube in a Cornish boiler.

BUREAU OF STANDARDS NOTES

Investigation of Feldspar and Its Effect in Pottery Bodies

As part of the deta led study of each of the constituent raw materials of a normal whiteware body, the Bureau, in coöperation with the American Ceramic Society and industrial users of feldspar, is investigating the physical properties of commercial feldspar and its effects in vitreous and semivitreous ware.

Feldspar (which is composed of potash, soda, alumina, and silica) acts as a flux at the maturing temperatures of ceramic bodies, and serves to bind the other materials into a common structure. This fluxing behavior, and the other physical characteristics of the feldspar, vary within considerable limits, and a systematic and exhaustive study of their behavior in such bodies is desirable in order that industrial users may have reliable data to guide them in the selection of material possessing the desired qualities.

The investigation is divided into two major parts. The first is in coöperation with several technical institutions, and will involve the determination of softening point, fusion point, screen analysis, and chemical composition. It is proposed to have the work on softening points, air analyses, and chemical analyses conducted by outside technical institutions as well as in the Bureau's laboratories, in order to obtain information on the normal error encountered in determinations of this kind.

The second part of the investigation comprises tests of physical character which are comparable with tests conducted in previous Bureau investigations on ball clay, whiting ($CaCO_3$), and flint (SiO_2). This will include a study of the effect of natural impurities in the feldspar on its viscosity at furnace temperatures, and will involve the following determinations on bodies containing the various feldspars: drying shrinkage; burned color; maturing range; resistance to chipping, impact, and temperature change.

Up to the present time 17 feldspars have been submitted for use in the investigation. Representative samples from each shipment have been submitted to the coöperating institutions and to the Bureau's laboratories for the determination of fusion points and grain fineness. The air analyzer will be used for the latter work. Results from screen analysis and softening point determinations have been received from one coöperating laboratory, and the last-named results check closely to those obtained at the Bureau. It is expected that the results from the major portion of the laboratory work of this investigation will be available in the course of approximately six months. The data so far obtained do not warrant the formation of any conclusions.

Formulas for Determining the Specific Gravity and Index of Refraction of Special Glasses

In connection with the Bureau's work on the composition and physical properties of special glasses, a study of the available data on this subject leads to the conclusion that the specific gravities and indices of refraction of all glasses of the soda-lime-silica series can be computed from the composition of the glasses.

The specific gravity (G) is obtained from the formulas

$$\begin{aligned} G &= g_1 + g_2 + g_3 \\ g_1 &= 0.33\,(x_1 - 30)^{0.45} \\ g_2 &= 0.02\,(x_2)^{1.08} \\ g_3 &= 0.03\,(x_3)^{0.98} \end{aligned}$$

in which x_1, x_2, and x_3 are the percentages of silica, soda and lime respectively.

The index of refraction (N_d) is obtained from the formula

$$\begin{aligned} N_d &= n_1 + n_2 + n_3 \\ n_1 &= 0.039\,(x_1 - 10)^{0.8} \\ n_2 &= 0.014\,(x_2)^{1.02} \\ n_3 &= 0.013\,(x_3 + 1)^{1.07} \end{aligned}$$

in which x_1, x_2, and x_3 are the same as above.

It is realized that the constants in these expressions are subject to some change since they are based on the composition of glasses computed from "batch composition" and not on analyzed glasses, and no information is available as to the amount of strain present in the glasses used for determining the specific gravity and index of refraction. However, the computed specific gravity of fine analyzed glasses which contained small amounts of alumina and magnesia, varied less than 0.3% from the observed values, and the computed index of refraction of the same glasses varied less than 0.005 from the measured index.

As a result of this work, the glass manufacturer should be able to determine the composition of his glass very quickly, because tables can be prepared from which it will be possible to determine the composition of a glass from its specific gravity and index of refraction, two determinations which can be made in a relatively short time, instead of by the much longer method of chemical analysis.

Also, the manufacturer of optical glass and optical instruments, to whom the index of refraction is a very important factor, will be able not only to determine what indices may be obtained in this series of glasses, but also to compute with considerable accuracy the composition of the batch required to yield a glass of given index of refraction.

A complete report of this work, which will include references to the data used, method of computation, and an outline of the proposed method of establishing more definite values for the "constants" of the formulas, is being prepared for publication.

Standard Density and Volumetric Tables

The Sixth Edition of Circular No. 19 of the Bureau of Standards, "Standard Density and Volumetric Tables," was issued during January, and copies may be obtained from the Superintendent of Documents, Government Printing Office, at 15 cents apiece.

This circular contains standard density tables and others of a similar nature which are most often required in physical and chemical laboratories. The tables given are based on work done by the Bureau and by other investigators. In the latter case due reference is made to the author or to the publication from which the information has been obtained.

Fifty-four tables are included giving information on the density of water from 0 to 102°C; the density of various percentages of ethyl alcohol at various temperatures; the per cent by volume and per cent by weight of ethyl and methyl alcohol solutions of known density; the density and pounds per gallon of milk and cream, and of petroleum oils; temperature corrections to the indications of hydrometers in alcohols, sugar, and sulphuric acid solutions, and petroleum oils; the relation between specific gravity and degrees Baumé for both heavy and light liquids; the relation between specific gravity and degrees A. P. I. for petroleum oils; the capacity of glass vessels as determined by the weight of water contained or delivered at various temperatures; the volume of milk and cream at various temperatures occupied by unit volume at 20°C (68°F); and master scales for the graduation of hydrometers to indicate percentages of ethyl alcohol by weight or by volume, or percentages of proof spirit.

CALENDAR OF CONVENTIONS

Organization	Date	Place
AMERICAN CERAMIC SOCIETY		
(Annual Meeting)	February 8–13, 1926	Atlanta, Ga.
(Summer Meeting)	July 6, 1925	Toronto, Canada
(Fall Meeting)	Oct. 1, 1925	New York City
Am. Assn. of Flint and Lime Glass Mfrs. (Annual Meeting)	July, 1925	Atlantic City, N. J.
Am. Electrochemical Soc.	April 23–25, 1925	Niagara Falls, N. Y.
Am. Soc. for Testing Materials	June 22–26	Atlantic City, N. J.
Baltimore-Washington Section (American Ceramic Society)	April 4, 1925	Washington, D. C.
Brussels International and Commercial Fair	March 25–April 8	Brussels, Belgium
Chicago Section (American Ceramic Society)	March 10, 1925	Chicago, Ill.
Manufacturing Chemists' Association	June, 1925	New York City
Natl. Assn. of Mfrs.	May, 1925	New York City
Natl. Assn. of Mfrs. of Pressed and Blown Glassware	March, 1925	Pittsburgh, Pa.
Natl. Assn. of Stove Mfrs.	May 13–14, 1925	New York City
Natl. Chemical Equipment Assn.	June 22–27, 1925	Providence, R. I.
Natl. Clay Products Industries Assn.	April, 1925	Chicago, Ill.
Natl. Lime Association	May, 1925	
Natl. Exposition of Chem. Industries	Sept. 28–Oct. 3, 1925	New York City

BULLETIN

of the

American Ceramic Society

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

Vol. 4 | April, 1925 | No. 4

EDITORIALS

A MILLION DOLLARS FOR RESEARCH

Not a bad idea. It is excellent. Before there is a possibility of its realization there must be an accurate survey of its need and a definite plan for its use. To have the interest earnings from a million endowment to spend in research without a definite plan for control and direction of its expenditure would result either in confusion or scientific aristocracy.

The ceramic industries need a research bureau or institute to collect and make application of information; to advise with the manufacturers and with the research laboratories regarding scientific fundamentals and their application to industrial ceramic problems; to compile bibliographies; to write books and, in general, to collect, correlate, evaluate and codify the vast fund of information now available. Large sums of money are being and will continue always to be spent in learning anew the facts which are already known. Most of this duplication is necessary as well as inevitable. Check observations are necessary especially under varied conditions and from various points of view. Duplication in research is not by any means useless, but it is folly to repeat investigations in which essential, fundamental and basic data are wanting or when a complete understanding is not had of the factors involved. We need a "loss and gain" analysis of the existing information if technical ceramics is to pro-

gress during the next thirty years in any such degree as it did during the last thirty.

Research facilities we have in plenty. So far as space and equipment are concerned more research men could be employed in the laboratories already available. There is no need for more laboratories. Then too, there are several universities with facilities which are not now, but which would be engaged on ceramic research if properly advised and assisted.

What is needed most is a survey to determine what investigations are most essential and to influence the laboratories to devote their attention to these essentials. If the writer had the annual earnings of a million dollar endowment to spend where it would be most beneficial to the industries they would be spent in an advisory research survey of the literature, the industrial needs and the available laboratory facilities.

With the inspiration, information and thoroughly informed advisory service which would thus be made available it would indeed be very unnatural and unusual if the ceramic manufacturers, singly and collectively, through their respective trade associations would not be employing to a much larger extent and much more profitably the research laboratories now available to them. And if this research advisory agency was functioned properly through and by the trade associations and the AMERICAN CERAMIC SOCIETY, it would represent a unit force that would develop a more liberal federal and state support of our present research and educational institutions.

Then too, there is a distinct need of more thoroughly collegiate trained scientists and technologists. We will not have an adequate number of more thoroughly trained men until more of our college graduates take more work in the colleges. This additional work is advanced work for a higher collegiate degree. Most students, however, cannot with their own resources afford the time and expense involved. Ten or twenty fellowships, at $1000.00 a year apiece, under strictly enforced conditions of qualifications and research problems would make possible the advanced training which is today so much needed.

The million dollar Ceramic Research Endowment is a good idea. It should be encouraged.

THE CERAMIC DIVISIONS IN THE FEDERAL BUREAUS

Are they equal to what they used to be? Are they meeting the present requirements as successfully as they did those of former years? A comparison cannot be made in justice to either the present or the past personnel but a review of the changes in character of research problems may be beneficial.

The bureau men of the former years placed into ceramic literature

exact information. They did the things most needed and helpful in their day. They could not have employed their facilities and time to a better advantage. And it is certain that if the same personnel had continued in bureau service they would be doing the same sort of work as the bureaus are today doing and in just about the same degree of effectiveness for they were men who grew in scientific skill and vision.

But ceramic science and technology have advanced. Much exact information has been checked and recorded and need not be repeated. We wandered through the wilderness of empiricism for nearly thirty years and are just now entering the promised land of ceramic science. We were guided only by empirical facts and methods during those thirty years of wandering. Each new fact established or new theory proved was a beacon light leading to many serious studies and debates. As soon as a new idea or fact came into view it became the subject of investigation by several. To the leaders during those early years of wilderness wanderings each new finding brought a thrill and a concern that left a vivid impression, so vivid, indeed, that in a casual glimpse backward they stand out individually and with undimmed light. Those were the happy pioneer days and lucky was he who then had the facilities and the time to make investigations.

Favorable to making strong impressions by these pioneers was the fact that the research workers of those years were almost wholly confined to the bureaus, state surveys and universities. Nearly 90% of the Annual Meeting programs of this Society consisted then of papers by men from these research institutions. This brought the bureau men much more into prominence than is now possible when more than 50% of the meeting programs are provided by industrial employees who have facilities and training for the conducting of research equal to those had by the men in the bureaus.

To compare the case at present with that of the past is like comparing the effect of the occasional light in the small town railroad yard to the massed effect of many lights in the large city yards. In the small yards the individual light receives undivided attention. It is recognized and remembered. But in the yard of the larger centers the individual light has no individuality except to him who needs be directed by it and who therefore seeks it out. The bureau workers during the "wilderness" days were marked leaders. They performed creditably. They will not be forgotten. But he who will seek from the present day maze of equally brilliant individuals those who are conducting the work at the bureaus, will find them meeting new problems by new methods but achieving things in quality, quantity and usefulness equal to the accomplishments of any of their predecessors.

The character of the problems has changed. Once it was empirical

studies of material mixtures to determine roughly the effect of the extreme composition variations. Methods of testing had to be devised. With results of these investigations now a matter of record, the present need is to study the product and the effect of variations in materials and in methods of fabrication on the properties which the product must have if it is to best meet service conditions. In short the major portion of the studies now is on product with some regard to materials and fabrication, whereas in the earlier years it was alone on the compounding and treatment of materials without regard to the product.

Then too, the present workers have more exact data, more accurate methods and apparatus and are more interested in fundamental facts. The present workers have these means and this vision of the needs of fundamental data as a legacy from those who searched in the years now past.

The present bureau men enjoy the collaboration of highly trained technical men from the industrial organizations. This too has been a matter of growth the credit for which lies in the general progress which has been made from the empirical to the scientific, from materials exclusively to products quite largely. The industrial technologist is more interested in product. He studies materials and processes with product of a standard quality as his goal. This has lead to improved physical, microscopic and chemical methods and in turn to product specifications and standardization.

With the more exact knowledge of materials and fuels, and of the economics of their use in fabricating products we have three distinct ceramic specialists—the ceramic artist, the ceramic scientist and the ceramic engineer. The plants need most largely the ceramic engineer and the bureaus the ceramic scientist. The engineer is he who employs the findings of the scientists. The artist is he who conceives the shapes, colors and that artistic creation which makes for the product a market demand. The demand for each of these specialists is not the same in all ceramic industries. Some ceramic lines need all three while others need only the engineer, the scientist or the artist. The bureaus, however, have today more than before a greater need for the scientist to supplement the engineering and art of the factory technologists. This narrowing of the function of the bureau men exclusively toward the rôle of the ceramic scientist is one of the inevitable results of the closer collaboration between the bureaus and factories.

And in collaboration with the producer is the user of the ceramic product. Thus is formed a mystic triangle of the neutral bureau scientist and the producer and consumer technologists. Great strides are thus possible. In place of exploring unknown limits of composition variations, they are now seeking the maximum and minimum of such physical properties of the

product as volume changes, conductivity, strength and di-electric resistance in commercial products and the relations of these properties to service life.

There can in justice be no comparison of the present and the past work of the bureaus. At no time have the bureaus failed to serve the ceramic industries in the manner most needed at the time. The present day bureau personnel is in every way equal to any that have in the past served, albeit their previous training must vary with the service they are to render. The bureau men today, more than in former years, must be more highly trained scientific investigators.

PAPERS AND DISCUSSIONS

WHAT THE INDUSTRIES WANT FROM THE CERAMIC ARTIST[1]

By Frederick H. Rhead

If the question, "What do the industries want from the ceramic artist?" were put to me as a psychological test to be answered in two seconds, I would be inclined to answer to the effect that they wanted the moon, and that they stood very little chance of getting it, even in this age of marvelous accomplishments. But I am quite sure that such an answer would be accepted as being neither conclusive nor comprehensive.

After a little thought, my mental reaction on this subject is one where my mind at once commences to formulate questions such as these:

What industries? What artists? What is the relation of a particular artist to a particular industry? What is the present status of the ceramic artist to the present type of ceramic organization in this country? Artistically speaking, how do our decorated ceramic products compare with the decorated ceramic products of our competitors in other countries? Who is to define what is and what is not artistic in ceramic products? Is it the aim of ceramic manufacturers to produce artistic products? To whom am I addressing these comments? Am I speaking as a manufacturer to ceramic artists, or as a ceramic artist to manufacturers? There are a hundred other questions of equal importance—assuming that this subject is important at all. Do the manufacturers know what they want from the ceramic artist? Do they want to know? Does the ceramic artist want to know what the manufacturer needs? Do either of these groups care, or are they particularly interested in essential requirements any further than those covered by the present law of supply and demand and present manufacturing conditions?

A manufacturer is necessarily bound by the limitations within his own organization. But I sometimes think that he rarely develops the possibilities within these limitations, because he unconsciously but quite deliberately imposes further and much narrower limitations on his organization by dictating or controlling a business policy where the artistic and technical standard of his product must be somehow in line, or in the same field as some group of competitors, or rather he appeals to a price market rather than to a taste market.

This statement may seem obscure and involved until it is realized that a sales appeal is first one of selection or personal taste, and then one of price. If two dinner services are approximately the same price, the customer will buy that which is the most pleasing—I will not say the one that is most artistic.

[1] Presented before the Ohio Ceramic Industries Association, January, 1925.

In order to test this limitation of possibilities (and I am thinking of this question from a purely commercial angle), visit half a dozen crockery stores as a layman and look for an American dinner service. What will you find? You will find that you have the product of some one hundred domestic concerns to choose from. What will be the essential artistic or ornamental difference between the products of these various concerns? So far as the layman is concerned, there is practically no difference except that the decorations vary in detail. Except for certain technical differences known only to the initiated, a product manufactured by one concern may easily have been manufactured by another. That very elusive but quite tangible and marketable quality called style barely exists in the ceramic industry today.

There has been no serious or sincere effort, artistically speaking, to develop a decorative style that can be instantly identified as being the product of some particular concern. In art pottery Rookwood has developed a style which is almost immediately recognized, and which, by the way, has not been successfully imitated by other art potteries after more than twenty years of effort. The Bachelor Tile Company of California has also developed a decorative style of its own.

The Czechoslovakian potteries are now producing ornamental wares which are beginning to appeal to the younger buying generation, and which if not noted by our domestic art potteries, will make terrific inroads in competition with domestic art pottery.

Some of our foreign friends have been making a close study of American organization methods, not as applied in our ceramic industries, but as applied by the Ford Motor Company and other tremendous organizations. The result will be a trade war that can well be feared by us, unless we use all the resources at our command.

The subject of my paper is not what the manufacturers want from the ceramic artist. The title is: "What the industries want from the ceramic artist" or in other words, what should be the contribution or active interest of the ceramic artist in connection with the development of the industry?

In attempting to answer this question, I am speaking as a manufacturer to manufacturers. First, because I have been concerned with organization, manufacturing, and marketing problems during the past ten years, and secondly, because it is a question that no ceramic artist could answer intelligently, unless he had acquired considerable business experience.

On the other hand, it is a question that no manufacturer can answer intelligently, unless he has made a close study of decorative styles; that is, he must be something of an artist. While my opinion of the business ability of the average American pottery manufacturer would not bear repeating here, I will say that he knows a lot more about art than the average ceramic artist knows about business.

Some of my friends who are manufacturers may exclaim, "But why should the ceramic artist know anything about business! We do not pay him for his business knowledge. We pay him for making decorations that will sell." Now I want to make it quite clear that I am not talking to this type of manufacturer. This is the man who manages or controls a little, six or twelve kiln plant, whose business is running on a shoe-string pocket-book and shoe-string brains, whose business outlook or vision lies no further than his nearest competitor, and whose chief concerns in life are the overdue notes in the local bank.

I have often wondered what would happen if Henry Ford should turn his attention to the manufacture of ceramic wares. I mean I wonder what would happen to the great majority of existing manufacturers. I mention Henry Ford at the risk of creating a smile, but after we have had our joke at the expense of the Ford hundred-piece dinner service, retailing for $2.00 or thereabouts, let us do a little thinking.

We already know that Henry Ford is already in the ceramic game. We know he uses millions of porcelain spark plugs. We know the Ford policy to acquire and control sources of supply, and to develop by-products. We know that in big business it is but a short step from the acquisition of raw material resources to the development of these resources, and to those who have followed Henry Ford's business career without prejudice, it will not be difficult to imagine what he could do in any branch of the ceramic game if he attempted to use his resources and genius for organization in connection with the manufacture of ceramic wares, which brings me to the question what the industries want from the ceramic artist.

They want what the ceramic artist cannot possibly supply unless the various industries are organized in such a way that they can use what he has to offer. I can best explain my point by referring to the founding of the AMERICAN CERAMIC SOCIETY, some twenty-five years ago by a handful of men who simply had to get together and talk shop. We all know what happened, and we know what a tremendous influence this SOCIETY has both in this country and in other countries, who are much older in the ceramic game than we are.

Having been brought up or dragged up in the decorative end of the industry, I have tried to find a handful of decorative men who would be interested enough in their jobs and far-sighted enough from a business point of view to want to get together in the same spirit as that of the men who met in those section Q meetings of twenty-five years ago.

Probably there will be such a group when the manufacturers realize that there is a vital need for such a condition.

It is a curious thing that the mind of the average manufacturer in the clay industries is so constituted that he cannot allow his artist to be the arbiter in regard to his decorative wares. The manufacturer himself is

the judge and jury. There is no research work in shape construction, color harmony, ornamental styles, or decorative process work.

The ceramic artist is not a creator of artistic wares. He is, so far as the white ware industry is concerned, a bench lackey who must respond to the whims of a man who may have a certain amount of taste, and who may possess a fairly accurate knowledge of what will sell. But if he is the controlling factor so far as the creator of new designs is concerned, it is too definite that what are considered as new designs are nothing more than variations of either a foreign product or the product of some domestic competitor.

Because the manufacturer is not a designer, he is not a creator. He is a producer, gaging his product by that of his competitors, who are all doing the same thing. Consequently, there is little difference or distinction between the products of the different plants. A pottery manufacturer goes to a lawyer, a patent attorney, an engineer, an architect, a physician, or any other specialist when he needs to be advised in connection with these professions. But I have yet to learn of an instance where he will consult with his art director or decorative man in regard to design or decorative styles.

I do not wish to give the impression that I am supercritical of the manufacturer, because if my comments are critical at all in connection with present conditions, I feel that the ceramic artist in this country is unprogressive, unbusiness-like, and from an organization point of view, possesses the type of mind of an alley cat. As an instance of this type of mind, I would refer you to the reports of the Art and Design Committee of the United States Potters Association.

Let us consider for a few moments the general field of activity open to the ceramic artist. The largest group industry employing the services of the ceramic artist is undoubtedly the white ware or utilitarian field.

The second largest group is possibly the floor and wall tile, faience, and terra cotta field. The third group includes the various art and so-called or alleged art potteries, or I might say, the small potteries who seriously attempt to produce artistic wares, and the larger potteries who produce commercial ornamental wares. The fourth group consists of those factories who utilize, or ought to utilize, the services of expert draftsmen in connection with the construction of the various shapes. I refer to the electrical porcelain, chemical ware, sanitary ware, stoneware, and any ceramic product where shape construction is an important factor.

Having broadly outlined the field of activity, it now remains to define the true profession of the ceramic artist. What is a ceramic artist? Is the gentleman who buys decalcomania, and who arranges these around the borders of dinner plates a ceramic artist? Is the gentleman who paints little sprays of roses and forget-me-nots on the sides of cuspidors

and other useful articles a ceramic artist? Are the gentlemen ceramic artists who have mastered certain practical and decorative tricks of the trade, and who do the same thing no better or no worse year after year? What about the modeler, the specialist who is responsible for the ornamental shapes? Is the engraver, a highly skilled specialist, responsible for some of the finely engraved designs, a ceramic artist? Where must we classify the man who makes the original designs for decalcomania? Are the decorators employed in quantity production ceramic artists? Are mold-makers, who specialize in decorated and ornamental wares ceramic artists? How about the practical potter engaged in ornamental wares? And the technical man interested in problems of color and texture? And the kiln fireman, who must have a thorough knowledge of oxidizing and reducing atmospheres if he is to produce acceptable colors and textures? Is the salesman selling ornamental and decorated wares a ceramic artist?

I would like to say that a ceramic artist is an individual who is directly or indirectly concerned in the development and production of ornamental and decorated clay products, but I question if this definition would be acceptable to the average manufacturer, ceramic decorator, or clay worker. I will say, however, that this definition is not only acceptable to me, but it is one that I apply in connection with my organization work.

Having outlined the field of activity and arrived at a more or less comprehensive definition of the profession of ceramic artists, we must now give some consideration in regard to comparative conditions involved in the production of decorative wares in this and other countries, and check these with the conditions involved in connection with the technical development in this country during the past twenty years. I can make my position clearer by first briefly outlining the technical development in this country. It is an acknowledged fact that the American ceramic manufacturer has realized the importance of the establishment of technical schools. We have these schools at various strategic points. These schools are growing in importance. They are at least the equal of similar schools in foreign countries, and they have fully demonstrated their value in connection with the growth of the industry. We have a CERAMIC SOCIETY which adequately and comprehensively covers practically every phase of the industry, and this SOCIETY publishes a *Journal* which is not equalled by any other ceramic journal in any other country.

The results of these activities are obvious. Technical development has expanded with the growth of these activities. From a technical point of view, we at least occupy an equal position to any other country, and from an organization point of view the American manufacturer can obtain what technical assistance he needs without going abroad for this type of skilled labor. I wish to emphasize the importance of this condition.

We have fine technical schools, a great technical society, the most valu-

able technical journal published, and as a consequence conditions are favorable for the training and development of efficient technical men.

Now none of these conditions exist in connection with the decorative side of ceramics. We have no schools for the ceramic artist and practical potter, and to date, the Art Division of the AMERICAN CERAMIC SOCIETY has not developed to that point where it can be considered as an important influence in connection with artistic development. There is no journal or publication in existence that caters to the ceramic decorative specialist. Consequently, with no provision for the training and development of the ceramic artist, it is natural and obvious that this type of skilled labor is practically non-existent.

If we consider the facilities and opportunities for the training and development of a ceramic artist in foreign countries, we will find that as much attention is given to the training of the artistic specialist as is given to the education and training of the technical man. Practically every town in England and on the Continent that possesses a pottery of any size is practically certain to have a well-equipped art and manual training school offering courses of instruction for the decorative specialist.

The various art magazines are interested in the decorative side of ceramics, and there is considerable literature catering to this particular field. As a result, our foreign competitors can obtain the services of highly skilled decorators as easily as they can obtain the services of technical men. The result is obvious. The concern with a well-balanced organization is more efficient than an organization with one or more essential specialists.

Dr. Mellor, the well-known English technical man, forcibly emphasized this condition during a recent address to his students, all technical men. He is quoted as stating: "About all the students present can take a hen's egg and analyze the shell and contents. Not a student present can lay an egg." Applying this reminder to the field of ceramics, it is not difficult even for an Englishman to see the point.

We have the men who can analyze and work out the various technical problems, but we do not have the men who lay the eggs, or in other words, we do not have the men who are trained and equipped to create, design, and produce artistic wares of a quality that will compare with American products in the furniture, textile, and metal industries.

There are, of course, notable exceptions, but I am taking the ceramic industry as a whole and considering the matter from an organization point of view.

In finally considering the question of what the industries want from the ceramic artist, a comprehensive reply then must meet this question squarely, and must take into consideration the various points mentioned. No plant or group of men can become an important factor in any industrial development unless conditions are favorable for such a development.

The ceramic art specialist is doing what he can under most unfavorable conditions, but he cannot accomplish much either as an individual or group, unless he enjoys the confidence and support of the manufacturer.

The present possibilities of the ceramic industry are such that those responsible for the growth of this industry must give serious attention to artistic and manual training in the ceramic fields. We must have ceramic art schools in such localities as East Liverpool, Trenton, Zanesville, and other industrial centers, and by this I do not mean schools where students dabble in elementary problems of surface decoration, but schools where the fundamentals of shape construction, design and decoration, modeling, mold-making, and the other practical problems involved in practical potting.

These courses of instruction will vary according to the locality of the school. Whether these schools will be under government or state direction and supervision, as is the case with most European schools, or whether they will be endowed by industrial associations, is a matter of no importance so far as the fundamental need is concerned. It is enough to say that when the various ceramic manufacturers as a group realize the vital necessity for artistic and practical training, these schools will begin to come into existence.

To conclude and to finally answer the question of the title of this paper, "What the Industries Want from the Ceramic Artist," is that which the manufacturers themselves must be largely instrumental in supplying, and before this can be done, the manufacturers must recognize the possibilities for artistic and decorative work when educational and industrial conditions are so organized as to make the creation of such work possible.

With due recognition that this is entirely an organization problem, the manufacturers will later come to recognize the tremendous commercial possibilities for artistic products that will be in harmony with the various phases of industrial and social activity in this country.

In closing, I would like to suggest that when the ceramic industries are brought to the same state of organization as exists in the Ford Motor Company, United States Steel Corporation, and other vast industrial concerns, that it will largely be because the manufacturer has come to accept the ceramic artist as a most vital essential in connection with production and marketing problems.

American Encaustic Tiling Co.
Zanesville, Ohio

BIBLIOGRAPHY AND ABSTRACTS ON THE UTILIZATION OF PEBBLY CLAYS FOR HEAVY CLAY PRODUCTS MANUFACTURE

By Fred T. Heath

General

Methods of handling brick clays containing stones. Jos. Keele. *Clay Worker*, **74**, p. 230.—If a clay contains only a few scattered pebbles or rock other than limestone or dolomite, then it may be worked, if its other properties are good. The non-calcareous pebbles can be crushed. For limestone pebbles, conical rolls are the simplest equipment. These remove the large stones and crush the smaller pebbles. With a Diesener clay cleaner, pebbles can be removed from plastic clay. Raising the mullers of a dry pan an inch or so above the surface of the pan allows the clay to be forced through the perforations of the screen plate while the pebbles stay behind and are periodically thrown out. Grinding the pebbles fine in a dry pan is effective but involves the provision of a storage room for drying clay or for use of a rotary drier. Limestone particles must be ground to pass a 30-mesh screen, otherwise the brick will be disfigured. Grinding processes are not usually effective because these methods of grinding do not reduce the particles this fine. A wet washing process is the only effective process, but expensive for common clays. One plant in the United States is using such a process. In certain parts of England the lime particles are ground as fine as possible and then the fired brick are loaded on cars and drawn through a pool of water. This treatment slakes the lime particles quickly and appears to do less damage than if they were allowed to slake and expand slowly from the moisture absorbed from the atmosphere. The Don Valley Brick Works in Toronto fire in continuous kilns with a strong reducing atmosphere and they have little trouble with their lime particles popping. Finally we have to consider the addition of some substance to the clay which would prevent the slaking of the lime after firing. The writer has made many experiments to this end but found that the only practical thing to do was to add some salt to the water used in tempering. A set of test pieces of fired clay containing limestone particles to which 1% of salt was added, have now been standing in the laboratory for about a year and show little or no indication of disintegration, while similar test pieces made up without the salt have gone to pieces long ago.

Stony brick clays. J. Keele. *Brick and Clay Rec.*, **56**, p. 527.—Enlargement of the article previously abstracted. Palissy, the famous French potter, experimenting with various clays in the sixteenth century and recording his impressions of them, says: "There are some kinds of clay which are of evil nature; because among them there are little stones, which, when the vessels are baked, the little stones which are in the said vessels are reduced to limes, and suddenly when they come to feel the humidity of the air, they swell and cause the said vessel to split in the place where they are enclosed, and this is because the said stones were calcined in the baking; and by this means many vessels are lost, however great the labor one may have employed upon them." This quotation expressed the experience of all clayworkers from Palissy's time to the present day. The one plant in the United States which successfully cleans glacial clay from limestone pebbles by a washing process is situated at Hutchinson, McLeod County, in Minnesota. Its operation is described in the report by Frank Grout[1] as follows: "The washing machinery occupies a space not over 20 feet square and 15 feet high and washed 130 yards of clay in a day. The clay from the bank is hauled by cable car to the washer, where it is mixed with an excess of water and agitated by a series of vertical

[1] "Clays of Minnesota," U. S. Geol. Surv., *Bull.* **678**.

rods fastened to a rotating cross-beam. The harrow-like motion of these rods tends to throw the larger pebbles toward the center and leaves the fine clay and sand suspended and distributed throughout the washer pit. A bucket elevator of continuous operation dips into the pit near the center and removes the gravel. The gravel, if cleansed, forms a by-product of considerable value. At the sides of the pit a screen of proper mesh allows the escape of the fine sand and clay to one of a series of open ponds in which they are allowed to settle. After a time some of the water is pumped off and the rest is left to sink into the ground. The sand naturally settles close to the intake of the pond and the clay is carried to the farther side. After partial drying, the material is taken to the stiff-mud machine where the clay and sand are mixed in approximately the same proportions in which they existed in the drift before washing. Experiments are now in progress to determine whether the clay is improved by standing in the settling ponds all winter. The gravel is sold for concrete. Both the clay and the sand contain a considerable amount of calcium carbonate, but if care is taken to remove the coarser sand, the lime does no harm and it is certainly less abundant than in the unwashed drift. The plant at Hutchinson is equipped with three round down-draft kilns and plans are made to double the capacity. It has been found possible with this clay, to produce a very good drain tile and hollow building block so that the production of common brick has become secondary." A face brick plant near Hamilton, Ont. fires their limey clay so intensely in round down-draft kilns that there is no bad effect from the lime grains. WM. BURGESS discusses this paper and recommends fine grinding.

Comment of W. D. Richardson on pebbly clays. *Clayworker,* **78,** p. 336.—Comment on paper read by GEORGE M. KRICK before the Indianapolis convention of the N. B. M. A. He relates his own experience with pebbles at a Minnesota plant prior to 1886. This was before rotary driers came into use and our clay was dried in the sun and wind and then stored in sheds. Our aim was not to grind up the pebbles, but to remove them and that is what I would do today under similar conditions. Mr. PRATT of Anoka, machinist, invented the "chain pulverizer." It is an efficient machine which does not grind the clay but whips it to pieces with the chain beaters, leaving the stone whole and as free from clay as though cleaned with a wire brush. These chains were riveted to two vertical shafts, geared together and running in opposite directions, spaced so that when the chains straightened out by centrifugal force, those of one shaft would just clear those on the other. The clay was fed into the center on top and in falling through the machine, was whipped by these chains. The outside casing was of flat bar steel, set in grooves cast in top and bottom plates, forming a flexible shell on which the clay would not build. Around this we placed a canvas cover to prevent the dust from flying. From this machine the clay was chuted into a rotary screen from which the clean pebbles tailed out of the building to the ground below. The machine was efficient but the wear on the links of the chain, as then constructed, caused frequent repairs. Improvement could now be made on such a machine. It required small power to operate and by using another set of pulverizers and screens for a second treatment of the screened material, the smallest pebbles could be removed.

There are three factors to be considered in grinding limestone in clay: (1) The percentage of limestone in the clay. (2) The fineness of the grinding. (3) The temperature at which the ware is fired and the duration of the high fire. E. CRAMER of the Tonindustries Laboratory, Berlin, made some experiments along this line from which he deduced an opinion that it was not necessary to grind the stone finer than one-twentieth of an inch in diameter. Later, MR. DE SHARENGRAD made a more systematic study of the lime-pebbly clays of central Europe. He washed out the stones and then ground and then sieved them into particles $^1/_{50}$, $^1/_{25}$, $^1/_{12}$ and $^1/_{18}$ of an inch in diameter. Some of each size were then mixed with the clean clay in the proportion of 2,

5 and 10%, respectively, and brick made from these different mixtures and fired. After the fired brick had stood in his office a month, those containing 2 and 5% of stone ground to $^1/_{60}$ of an inch diameter still remained good, though the brick containing 10% of stone of this fineness had begun to split in two weeks. Brick of all the other grades of fineness, containing more than 2% of stone, were damaged more or less. As DE SHARENGRAD found it impractical to grind the stone as fine as $^1/_{60}$ of an inch diameter, he then tried the effect of longer duration of the high fire. He had been stopping the firing as soon as the kiln had reached a definite temperature, but a microscopic examination showed that the stone remained free and uncombined with the clay. It was therefore sought to bring about a chemical combination by holding the high heat for a longer time. After numerous trials, DE SHARENGRAD fired his clay, holding the high heat for 48 hours instead of 8 hours, with the result that the extra time the goods were exposed to the heat enabled a combination to take place between the lime and the clay and that brick fired under these conditions not only remains free from popping or pitting, but is actually stronger, the slight vitrification that has taken place binding the particles more closely together. DE SHARENGRAD also found that the brick that were dipped in water immediately after being taken from the kiln, "remained sound, even when the largest particles of lime were present."

Treatment of clay containing pebbles. ELLIS LOVEJOY. From page 21 of his book "Economies in Brickyard Construction and Operation."—"Clays containing pebbles should be worked in a dry condition by putting them through a whipping machine to loosen the pebbles from the clay, followed by screening to remove the pebbles. If the material as it comes from the pit is wet, a rotary drier should be used for drying and then the pebbles whipped loose and screened out. On one yard, the pebbles were removed in the dry pan. The mullers were raised an inch or two from the grinding plates. The clay required no crushing except to loosen the pebbles, which could be done in this way. The pebbles remained in the pan while the clay passed through the screen plates. At frequent intervals the pan was stopped and the pebbles shoveled out. Fortunately, the brick machine was of small capacity. Where the pebbles are of some size, they can be removed by grooved rolls, but any small pebbles will pass the rolls and appear in the brick, oftentimes with bad results. Where the clay contains pebbles, especially of limestone, and they are not or cannot be removed, the grinding should be very fine in order to reduce the size of the lime pebbles small enough so that they will not cause 'popping' in the fired brick."

Limestone pebbles in surface clay. QUES. AND ANS. *Brick and Clay Rec.*, **47**, p. 514. OHIO.—We are desirous of being informed as to the most practical method of separating small limestone pebbles from a plastic surface clay.

ANS.—We know of no practical method of securing the elimination of small lime pebbles. The larger stones and boulders can be taken out by using conical roll crushers and disintegrators, by which the stones are gradually worked out of the machines without passing between the rolls. The small lime pebbles problem is best solved by crushing and grinding them so fine that the particles cannot exert a sufficient expansive force to "pop" and so scar the ware after firing.

Brick and Clay Rec., **47**, p. 601.—Additional information on the subject of the above question is volunteered from a reader. When the limestone pebbles are soft and small and are what are commonly called concretions, such as those that form in the loess clays and are called "loess puppchen," little dolls in the clay, such pebbles may be safely crushed fine, down to $^1/_{20}$ of an inch or better, to $^1/_{30}$ of an inch in diameter, and left in the clay. This is especially true when the clay fires to a close, dense body and no water can be absorbed to cause slaking, also when the finished brick possesses great strength to resist expansion. This method is also applicable when the lime is of a

porous nature, having little expansion power, but tending rather to close up its own porosity when the molecules expand on uniting with water. It will readily be seen that this problem becomes an engineering study, the idea being to reach a balanced condition in the clay, the force of the lime in hydrating being so minimized as to cause no harm.

With other types of lime pebbles and clays, such treatment will not be sufficient to accomplish the desired result. Glacial clays containing small pebbles or broken bits of hard limestone, must be so handled as to remove the pebbles. Large pebbles can be removed by conical roll crushers, as is done with the Chicago clays, this treatment also being applicable to moist clays as they come from the bank to the machine. Clays containing many small pebbles, ranging down to buckshot and even duckshot size, should be gathered dry and given a complete processing in dry pans with suspended mullers, then elevated to piano-wire screens where they are screened to $^1/_{16}$ of an inch, giving a clay meal about like the meal used in coarse corn bread. The tailings should be returned to the dry pan and the pan cleaned every 15 to 30 minutes as experience proves is most desirable. The best test to determine whether the clay is being successfully treated is to place a finished brick on a steam radiator or in any other dry, warm place and to watch it for a breaking down of texture or "popping" due to slaking of the lime. Striking two bricks together to determine the quality of the ring, if there is any at all, is an excellent test of whether or not the brick retains its structural integrity. The dulling of sound when two such bricks are struck together as compared with the clear ring of two other bricks which have lain out-of-doors for some time, is a good indication of pebble slaking.

Eliminating small gravel in clay. QUES. AND ANS. *Brick and Clay Rec.*, **48**, p. 347. WEST VIRGINIA.—We are bothered to know what is the best method to follow in getting rid of the small gravel in our clay.

ANS.—Small gravel is of common occurrence in many clays and its elimination is always difficult. One method would be to put the clay through a rotary drier and then crush the material in the dry-pan or a swing hammer crusher and then run it over a fine screen. This would make the gravel so fine that the small particles would not bother the fired material. By the use of a strongly reducing atmosphere in the kiln during the latter stages of the firing, the fine particles of lime are rendered still less dangerous. Another method which is successfully used by an Ohio plant is to wash the clay in such a way that the clay particles are floated out. The gravel is thus separated in a very clean state and is shipped in carloads to a gravel company. The water that is used in the washing process and which contains considerable fine clay, is used for pugging the material. After washing, the clay is dried in a rotary drier and is practically ready for the pug mill. The equipment necessary for this operation is rather elaborate, but this particular company is turning out material that will compete in price with any manufacturer in the state of Ohio. Furthermore, the plant is making a good profit and is manufacturing both brick and hollow tile.

If the clay is one that can be put through a heavy smooth roll crusher (one that can be set very close together), it may be possible to crush the gravel fine enough in this way to bring about the same effect that would be secured by drying and putting through a pan. This at least, would be a great improvement over the disintegrator, the latter being a machine that aids in no way in overcoming the difficulty. The smooth roll crusher would also be a cheap method.

Pebbles break cutting wires. QUES. AND ANS. *Brick and Clay Rec.*, **48**, p. 547. NEBRASKA.—I would like to get your advice on grinding clay. Some of our clay contains small pebbles or gravel and one layer contains soft lime concretions. The latter fire white and do not slake in the fired brick but will crack some of the brick in drying, and

being rough, will break the wires on our cutter. The gravel breaks the wires also when it comes opposite the opening between the platens on the cutter. We use a disintegrator for breaking up the clay but we cannot get it close enough together to break up the pebbles sufficiently small to save the wires. Our clay is wet enough most of the time to pug without adding water at the pug mill, so we do not think that we can use a dry pan. Would a wet pan do the work in breaking up the pebbles and concretions fine enough so that they will not break our wires, or would a smooth roll disintegrator do it? We make side-cut stiff-mud brick.

Ans.—As your clay comes from the bank in a very wet condition, it will be impossible to get any efficiency out of a dry-pan, while a wet-pan is a mixing machine and not a grinding machine. It would seem advisable to put this material first through a disintegrator and then through a smooth roll crusher with the rolls set close together. If possible, the disintegrator should be set directly upon the rolls or a combination disintegrator and smooth roll crusher should be installed. This should eliminate the trouble, at least it will better conditions very materially.

Niggerheads troublesome in crushing. Ques. and Ans. *Brick and Clay Rec.*, **51**, p. 48. Illinois.—We are up against a hard proposition in crushing our shale. Besides other difficulties, this shale contains niggerheads of sizes varying from very small up to four or five inches in diameter. On account of these niggerheads, we were unable to install a roll crusher.

Ans.—With regard to the niggerheads, these will have to be picked out by hand in most any case except in the event that the clay containing them is soft enough to be crushed while the niggerheads are being thrown out at the same operation. This method is being followed at some of Chicago's brickyards where large nodules of limestone occur interstratified with the clay. The method followed in this case is to put the material through conical rolls where the angle of "bite" is such that the clay is "swallowed" while the nodules are thrown off. This process, of course, can be used only in cases where the clay and the niggerheads differ in hardness so that the difference in their angle of "bite" can be made use of.

Lime in the overburden. Ques. and Ans. *Brick and Clay Rec.*, **53**, p. 568. Alabama.—We are having trouble with severe "white-wash" in our brick which probably occurs through unremoved overburden impregnated with lime.

Ans.—Locate the limey clay with hydrochloric acid. It may be possible to pick out and discard the clay that is impregnated with lime but if this is not practicable, then we suggest fine grinding and the addition of the barytes. Fine grinding breaks up and distributes the finely ground lime particles all through the mass of the ground clay. This procedure eliminates, to a high degree, "popping" of the lime pebbles in the finished fired ware. This pitting is due to the lime oxide which hydrates and oxidizes and reverts back again, after firing, to the carbonate. This process is accompanied by a swelling of sufficient force to break away the surface skin of the ware leaving the unsightly white spots to show on the ware. Bear in mind that fine grinding does not eliminate "white wash" but it does prepare the lime for neutralization by adding the barium carbonate. Scumming is also produced by using coal that has a high sulphur content on a clay such as you have.

Stones in clay cause grinding trouble. Ques. and Ans. *Brick and Clay Rec.*, **53**, p. 982. Quebec.—We have always had a little trouble with stones in our clay but up to this time a pair of rolls could grind it well enough. This summer we began mining a new field and we met with such a lot of big hard stones that we were finally forced to stop. Our rolls could not pulverize our clay sufficiently and we wanted to find a machine that would pulverize the clay for an output of 100,000 bricks a day and in a condition that would enable us to make wire-cut brick. What would wet pans do?

The pair of rolls we have been using are 13 and 19 inches in diameter, the smaller one being armed with six knives. From these, the clay goes through a pug-mill in the press. The stones are generally lime and boulders, from pebbles to three-inch pieces. The deposit is not regular, but we have to meet with quantities of these stones here and there. If we could not pulverize the stones it would mean a move of $2000 and the loss of ten acres of good clay.

It is impossible to throw out all these stones in the mining without considerably increasing the cost. On the other hand, we must add a little sand to our clay; the addition of the ground rock could but add to the quality of our brick. We have received the offer of a pair of rolls 30 inches in diameter but smooth. What would our rolls first, and the big ones under, do?

Ans.—We are of the opinion that since you have limestone to contend with in your clay, it would be best for you to get a fair representative sample of the clay as it will run with this rock in it. This should be ground in some way, by hand if necessary, and made into some sample brick. These should be fired in the regular way in order to determine the effect of the lime on the brick. It may be that this test has been made, but you should find what this limestone is going to do to your brick before putting in machinery to crush it. It is obvious, of course, that adding ground limestone to your clay is a different proposition from that of adding sand. If the limestone does not ruin your clay, you should have a comparatively easy time in grinding.

With rocks of the size that you have in your clay, a dry pan should have no trouble in grinding it with no preliminary crushing. We are inclined to believe that a secondary pair of smooth rolls, taking the material after it passes through the first pair of rolls, would do the work of grinding satisfactorily up to their limit of capacity.

Lime in a calcareous clay. Ques. and Ans. *Brick and Clay Rec.*, **54,** p. 806. New York.—Will you kindly advise me whether a clay which contains 13.43% of lime and 5.35% of iron oxide should fire red or yellow? The clay in fact fires red. How much lime should a clay contain to be classified as a calcareous clay?

Ans.—We would expect a clay containing 5.35% iron oxide and 13.43% lime, to fire to a buff or yellow color. However, it is hard to ascertain from an analysis what color a brick will fire because the physical state in which these ingredients exist in the clay mass influences to a great extent, the color to which the brick will fire. Some people claim that a good building brick can be made from a clay containing as much as 20 to 25% of lime carbonate, provided it is in a finely divided condition, and if vitrified ware is not attempted. If, however, a quantity of lime is contained in the clay in the form of pebbles, then much damage may result from bursting of the brick when the lumps of burned lime slake by absorbing moisture from the air. Clays containing a high percentage of lime carbonate are used in making common brick in Michigan, Wisconsin and Illinois.

The effect of lime in clay is as follows: It is probably most effective in the form of carbonate, and if finely divided is an active flux. When clays containing it are fired, they not only lose their chemically combined water, but also their carbon dioxide, but while the water of hydration passes off between 840°F and 1112°F the carbon dioxide does not seem to go off until between 1112 and 1562°F. In fact, it probably passes off at a higher temperature than this.

The result of driving off this gas, in addition to the chemically combined water, is to leave calcareous clays more porous than other clays up to the beginning of fusion. If the firing is carried only far enough to drive off the CO_2 gas, the result will be that the quicklime thus formed will absorb the moisture from the air and slake. No injury may result from this if the lime is in a finely divided condition and uniformly distributed throughout the mass, but, if on the contrary, it is present in the form of lumps, slaking and accompanying swelling of these lumps may cause the brick to split.

If, however, the temperature is raised higher than is required simply to drive off the carbon dioxide, and if some of the mineral particles soften, chemical reaction begins between the lime, iron, and some of the silica and alumina of the clay, the result being the formation within the clay of a new silicate of very complex composition. The effects of this combination are several:

In the first place, the lime tends to destroy the red coloring of the iron and imparts instead a buff color to the fired clay. This bleaching action, if we may call it such, is most marked when the percentage of lime is three times that of iron. Another effect of lime, if present in sufficient quantity, is to cause the clay to soften rapidly, thereby sometimes drawing the points of incipient fusion and viscosity within seventy-five degrees of each other. This rapid softening of calcareous clays is one of the main objections to their use and on this account also, it is not usually safe to attempt the manufacture of vitrified products from them, but the presence of several per cent of magnesia will counteract this. It has also been found possible to increase the interval between the points of incipient fusion and viscosity by the addition of quartz and feldspar.

Bothered with stones in clay. TRADE QUIZZ BOX. *Clayworker*, **79.** QUESTION.—We are much bothered with stones from one-half inch to two inches in diameter in our clay. What machine should we use to crush these stones?

ANS.—Rotary drier, dry-pan and screen. Expensive but practical. Conical rolls remove big stones until rolls wear. A disintegrator will snap out many stones but neither this nor rolls will completely eliminate stones. By CAREY P. ELLIS.

Specific Installations to Handle Pebbly Clays

Working a wet limey clay. GEORGE M. KRICK, Decatur, Ind. *Clayworker*, **77,** p. 243.—Their territory, northeastern part of Indiana, does not possess a clay deposit free from pebbles, and the greatest difficulty encountered in the manufacturing of ware from this clay is the limestone pebbles which all of these clays contain. In order to remove this objection, the only thing was to grind the limestone to a very fine state not to allow any of the pebbles to exist that would cause any eruption on the finished ware.

Methods of doing this were as follows: (1) Remove the moisture. (2) Pulverize and screen the clay.

The moisture is removed by means of a rotary drier. This drier is seven feet in diameter and seventy feet in length and has a capacity of 30 tons per hour.

Objections to rotary drier: (1) Investment. (2) Fuel consumption. (3) Power required. (4) Dust. (5) Extra labor.

Fuel consumption depends on: (*a*) Moisture in clay. (*b*) Condition of clay, fine or coarse. The finer the clay the easier to dry and less fuel and greater capacity. (*c*) Fuel depends on the quality and preparation. Egg coal preferred, as it gives a free passage of air. It is not necessary to have a great heat but the passage of a large volume of heated air to pass through the drier. The fuel also depends greatly upon the personal equation of the fireman.

Cost of fuel to operate this drier varied from 25 to 50% per ton of clay depending upon the conditions.

Dust.—As the clay in the drier is being continually agitated, a large volume of air being drawn through creates at the exhaust fan a large quantity of fine dust, which is taken care of by means of a settling chamber and stack. The settling chamber has a capacity four times that of the exhaust fan so that when the air leaves the fan it travels at a much lower velocity, which is a great aid in settling the dust and prevents it from going out into the open.

Power required to operate this drier under full load is 15 h. p. and 10 h. p. to operate exhaust fan.

Advantages of rotary drier: (1) Uniform moisture in clay. (2) Lessens cost of grinding. (3) Removes all vegetable matter. (4) Makes possible to work clays that otherwise could not be used. (5) Gives better mixture of clays.

The clay from the rotary drier is fed into a ring hammer pulverizer.

Objections to pulverizer: (1) Power. (2) Capacity. (3) Dust. (*a*) Large amount of power in proportion to capacity in tons of clay. (*b*) Great dust agitator-pulverizer must be inclosed and dust removed by an exhaust fan. (*c*) Wearing parts must be removed often. High consumption of lubricating oils.

From the pulverizer the clay is elevated to the screens which is really the most important equipment where limestone plays an important part.

Two gravity screens are used. Top screen is equipped with an 8-mesh wire cloth screen which removes all the coarse clay and gives greater capacity to the bottom screen. The bottom screen is equipped with a slotted wire screen. The wires are double-crimped and rolled so that there is no possibility of wires slipping so as to make an inaccurate sizing. Size of slotted wire screen opening $^1/_{20}$ x $^1/_2$ inch, size of wire 0.072, surface 72 square feet.

In practice it is found true that the greater the per cent of lime the finer it has to be ground. This plant was so equipped to grind as fine as 40-mesh.

The objection of fine grinding: (1) Difficulty to carry and store. (2) Cause great columns of dust. (3) Lessen capacity. (4) Drier and kiln loss. (5) Finished product inferior in quality. (6) Impossible to feed regularly into pug mill by means of disc feeder.

By not working a clay whose contents will exceed 5% in lime pebbles, we have no trouble with lime eruptions to injure the quality or sale of the ware.

Advantages of fine grinding: (*a*) The clay is not so tough and sticky, breaks up well and made easy to work in pug mill, making complete homogeneous mixture which is very essential to making hollow ware. (*b*) Before this process was installed an average of eight tons of ware an hour on a 44 x 20 sewer pipe press has been increased to an average of eleven tons per hour. (*c*) While the capacity has been increased, the operating load remains the same. No improvements or changes of any kind have been made in the power plant, but upon comparing records show that no more fuel was consumed and by indicating the load show no increase in h. p. (*d*) By having this clay in almost a perfect homogeneous material has decreased the drying time 25% and dry room loss from 5 to 10% to less than 1%. (*e*) Average time of firing a 40-foot kiln of 155 tons of ware was 95 hours, has been reduced to 70 hours, making a saving of about 25% in time, and firing loss has been reduced from 20% to less than 10%. (*f*) The color of the ware has been somewhat unpopular owing to the lime, but the ware has a good smooth surface and a clean metallic ring when struck with a hammer and will withstand more severe handling.

Discussion follows: WILLIAM HAMMERSCHMIDT, Lombard, Ill.: We had the same trouble as MR. KRICK. We are located in northern Illinois and had limestone in our clay. We had our troubles and we changed to the dry clay system putting in a Penfield disintegrator. We have a large dry house. We dry our clay about six weeks in advance of the time we are going to use it. We run our clay through the disintegrator, which is fed by a conveyor which runs underneath the storage bins and feeds uniformly. We take up all the lumps in that way. Our screen is about 8 wires to the inch. The tailings return to the Williams pulverizer, whereby we increase the capacity of the machine so much more, that we could use a smaller machine. We take out about 50% of the clay at the first screening and by returning to the pulverizer we have a con-

tinuous run until everything is pulverized to the fineness of corn meal. We have reduced our time of drying and firing and have better ware. We dry our drain tile on the flat.

OTTO TRAUTWEIN, Chicago, Ill: Does MR. KRICK put his clay through the rotary before or after it goes to the storage bin?

MR. KRICK: The clay is brought in and dried before it goes to the storage bin. It is dried and screened and then placed in the storage bin.

W. C. HOOVER, Portland, Ind.: At the Portland Drain Tile Company we got into the lime trouble before MR. KRICK did. Along in 1913 we began to run short of surface clay as we call it, and we could not get any clay near us so we had to shut down. We are making 32-inch tile at the Portland plant out of hard pan and a surface clay above that. For two years we had more trouble than you can imagine, but we finally got the limestone handled successfully. We had a Williams crusher put in and we built a large storage bin which helped. Our bank varies from 12 to 15 feet. As MR. HAMMERSCHMIDT says, we have eliminated our losses in the sheds for drying and somewhat in the time of drying also, but the best thing of all, we improved the quality of our ware very, very much.

W. L. BELTZ, Mowrystown, Ohio: What size mesh does MR. KRICK use? Does it run as high as 40-mesh?

MR. KRICK: It varies in my clays. In some places it runs as high as 30%. We have carefully analyzed the amount of lime, and have places where it runs as high as 25%. We never try to grind that clay. We use as high as 30- to 40-mesh but are troubled with dust.

MR. HAMMERSCHMIDT suggests use of a worm feeder run slowly to feed the pug mill.

Plant of the Delaware Clay Manufacturing Co. F. E. MILLER. *Clayworker,* **63,** p. 643.—General description of the plant. After being hauled inside, the clay is dumped into a hopper and by means of a drag chain conveyor, is fed into a coal-fired drier which is 40 feet long and $5^1/_2$ feet in diameter. This large drum is revolved slowly, and being set on a slight angle, provides a gravity discharge. An exhaust fan draws the heat through in the same direction as the material, and aids in getting the dust through, as angle iron projections on the inside reduce a large proportion of the clay to dust. After passing through the drier, the material is raised by a chain elevator to the screens, these excluding all stones larger than a hen's egg, these passing by a chute to the outside of the building, the finer material being fed into nine-foot dry pans and crushed. From here it is elevated and passed over a series of fine-mesh screens through which nothing but dust will go, this being fed into a storage hopper ready for the eight-foot tempering pans. The dust covered gravel that is excluded is passed through a washer and sold as a by-product, while the clay-laden water is utilized in the tempering pans.

The separation of stones from clays. C. H. SOLFISBERG, Aurora, Ill. *Clayworker,* **58,** p. 512.—Lime is not so important in manufacturing common brick, because a pop in the face can be overlooked. Limestone pebbles from the size of boulders down to fine dust occur in the clays of Wisconsin and Northern Illinois. There is a difference between air slaking and water slaking, the first being a short direct combination, the latter is a longer timed double reaction and lower pressure is exerted. I have given the above theory to show you that a brick can often be saved from popping by soaking in water. This was discovered accidentally due to rain. We must find some method of removing limestone. The entire content can be removed by suspension of clay in water, passing over sieves and settling out in vats, but the excessive cost makes it impractical for the common brick manufacturer. There being a few advantages in a small lime content, such as aid in drying, and help through sudden changes in temperature,

we need not remove all the lime but must have it sufficiently reduced in size. The method I will speak of, is in successful operation at the present time and makes it possible for us to make a strong brick from a clay running a strong 10% limestone. Ten per cent limestone is excessive and appears to be gravel instead of clay. I do not think this method is perfected as yet and each clayworker would have to alter it for his special clay. Pick and shovel methods with aid of dynamite removed larger stones at a fairly low cost. There are cheaper methods of winning but not for this clay. A piece of clay when struck by a hammer will break up without touching stones within it. Hammer mill purely impact, would do the work, reduce the clay and not the stones. A machine was built and installed. I will not detail screen trouble, but we tried all kinds until a piano wire did the work. The hammer mill is constructed with open grate bottom and six-inch grinding plate.

This method has its disadvantages of course. A wet clay separates less rapidly and has to be run through the system until stones only return. If clay is too wet, the mill will plug up. Wet clay is dumped from cars to dry-shed floor and run through later. The average bank moisture is nicely worked. A clay drier would make the system more perfect as stones would return clear of clay. As to the cost of operation, a 50 h. p. motor drives mill, cable drum and conveyor belt, and takes clay as fast as one man can feed it. The hammer, if of cast steel, would last about one day; tool steel, best obtainable, will wear off an inch in ten days of damp clay run. Manganese cast steel hammers have just been installed and are guaranteed to last over twice as long as any tool steel made. In dry clay, the wear on mill is lessened greatly. The case of the mill will last two seasons if one inch thick of cast iron; $1^1/_4$ inch steel bar grating will last about a season. This is for a very stony clay and wear will vary in proportion to stone content.

This method reduces clay to $^1/_8$ inch and less. The estimated cost of preparing clay for the brick machine is thirty cents per yard. If less than $^1/_8$ inch material is desired a crusher can be used since stone content has been reduced to about 1% in a 10% lime clay.

Winning the fight against failure. ANON. *Brick and Clay Rec.*, **49**, p. 410.—Manufacturers of brick and drain tile with their clay part of a gray glacial drift, containing an unusually high percentage of limestone and gravel, both of which had to be removed if a satisfactory product was to be obtained. Practically every method of eliminating the limestone pebbles and gravel has been tried. After the failure of other methods to successfully accomplish the separation of the impurities from the clay, a washing machine, which was designed by the owner of the plant after many years of experimenting, and which is somewhat similar to those in use for the same purpose in Europe, was erected. The parts of the machine were, in fact, imported from Europe. The method has been used five years at this plant. It is an expensive and ordinarily undesirable process.

The washing machine itself is about 15 feet high and 20 feet square, being capable of taking care of 130 yards of material per day. When the clay is thrown into the machine from the car, it is mixed with an excess of water in a cylindrical washing pit at the bottom which is about 4 feet deep. Here the mixture is agitated by means of a series of vertical rods that are suspended from the cross-beams of a rotating wheel arrangement, said beams centering in a revolving shaft in the middle of the pit like spokes into the hub of a wheel. The movement of these rods in the machine throws the larger pebbles toward the center of the washer while the fine clay and sand become suspended in the water and distributed in a fairly even manner throughout the pit. The gravel and large pebbles are removed from the center of the washing pit by means of a bucket elevator that is operated continuously. This elevator, since it is attached

to the center shaft, revolves with the same speed around the pit as the rods that stir up the water. As the buckets are filled, they are elevated to the circular shelf at the top of the machine, where they deposit their contents. Following the course of the buckets is a rod attached to the center revolving shaft that sweeps the discharged material into an inclined trough at the rear of the machine. Since the buckets dip considerably below the surface of the water in the washing pit in removing the pebbles of limestone and gravel, they are bound to elevate some of the suspended clay. In order to reclaim this material, the inclined trough into which the elevated material is conducted is kept overflowing with water, this again suspending the clay particles and carrying them over the edge of the trough back into the pit. After the gravel has been swept into the trough it gradually works to the other end where a second elevator is at work raising it up and over a platform from which it throws it in a pile on the ground. A stream of water is kept running down this platform washing out of the buckets all of the suspended clay that may have found its way to that point, sending it back into the pit.

The gravel is so clean that it may be used for concrete work. Going back to the clay in the washing pit, we find it is suspended there in the water with fine particles of sand and is allowed to escape through a screen of the proper mesh on the front of the machine. The passing of this clay through the screen insures only the very small particles of clay and sand getting through and prevents any of the large pebbles, either gravel or limestone, from finding their way to the settling pond to which the suspended mixture is led from the washing pit by means of a trough.

The clay is allowed to settle in one of the three or four ponds. The sand being heavier, settles nearest the intake, while the finer and lighter clay matter is carried to the other end of the pond. This results in a very uniform gradation from the sand at one end of the pond to almost pure clay (90% kaolin) at the other end. After partial settling, some of the ware may be pumped off and the rest allowed to evaporate and sink into the ground. The clay is then subjected to one year's drying and weathering.

When ready for use, after having been in the field for a year, the clay and sand are again mixed in approximately the same proportions as they originally existed in the pit and sent through the ordinary processes of manufacture. The clay in the ponds from which the pug mill is being fed, is in a comparatively loose and unpacked condition and is too soft to support the clay gatherer or a cart after a rain. It is necessary, therefore, to guard against this emergency if the plant is to be kept operating at capacity throughout the season. This is done by transporting some of the weathered clay from the drying fields to solid ground. Two horses and as many carts are continually in use performing this duty, adding another item to the cost of the manufacturing.

This system represents a tremendous investment and much additional expense above that usually met with in this branch of the industry. However, it opens up for utilization, a vast amount of clay that has heretofore been considered worthless because of its impurities.

Pebbles in clay. Ques. and Ans. *Brick and Clay Rec.*, **42**, p. 275. California.—We have a limestone clay full of pebbles and experience considerable trouble with it. Can you suggest some remedy?

Ans.—There are crushers on the market that are said to remedy troubles such as you are experiencing. There also is machinery expressly made for washing clays that is used by brick and tile makers. A hardwood washer which we have seen, satisfied its builder. It is a circular vat about 14 feet in diameter. There is a shaft in the center and on the top of that is a bevel gear and a band wheel. There is a lever near the bottom to which is fastened a chain drag made of two or three 3 x 4 scantlings with long teeth.

One corner of this drag is fastened to this chain and the other to the center shaft. Dump your clay into the vat from the cart, a little at a time. An inch and a half of water should go into the clay continuously. The slush from the vat goes into a screened box say of 4 meshes to the inch for brick and tile. From this box the slush goes to the drying places, of which there should be two. It can run through a common wooden trough and should spread over a considerable territory. Our friend washes the clay in the spring and lets it lay until the next year before he uses it. In this manner it freezes and weathers and is in a good condition to use.

To eliminate lime pebbles. *Brick and Clay Rec.*, **43,** p. 692.—Suggestions of Otto Pommer of Quebec, Canada, were submitted to an experienced brickmaker, whom he knew had gone through a long series of experiments with the object of eliminating the lime pebbles from his shales. He writes us as follows:

I think that Mr. Pommer is correct in his description of the chemical action of lime pebbles, and two of his suggested methods would doubtless be satisfactory, *viz.:* To wash the material when the lime is in large enough pebbles to be removed by washing; or by increasing the temperature of firing the brick, provided the material will stand the higher temperature and that the resulting colors would be satisfactory. The other two methods I do not believe feasible. I have found it impossible to grind pebbles fine enough to prevent their popping. Dipping the brick in water after leaving the kilns would only result in bringing the pebbles out quicker. I would suggest that the most practical way to eliminate trouble with lime pebbles is to keep them out of the material when it is loaded in the pit. In nearly all shales and many clays, the pebbles are found not in the material itself, but in the overburden. Therefore, by careful stripping and using muriatic acid to show effervescence when the pebbles are present, it is possible to practically eliminate them.

Mr. Pommer's article follows: The existence of lime in clays or shale used for brickmaking is a source of constant trouble and it is up to every plant which has the trouble to find out which remedy will work and suit the conditions best. Carbonate of lime is often found in clays. Sometimes it is very fine in which case it does not do harm but acts as a flux, and in other cases it appears in the form of lime pebbles in sizes that vary from that of a nut down to a head of a pin. When firing, the lime loses the carbonic acid, leaving oxide of calcium, known as unslaked lime, which absorbs the water from the air, forming hydrate of lime, known as slaked lime. In this stage the lime increases its volume, forming cracks in the brick which grow bigger until pieces fall off from the brick and cause the brick to burst. Looking at those pieces the slaked lime is easily seen. There are four ways known which might help.

1. To wash the material. This is the safest but most expensive way. To do this, large basins and a large amount of water is necessary. If the clay contains lime in small amounts and fine particles only the firing color of the products will be very much improved and the prices obtained might pay the expenses of such washing.

2. To reduce the size of lime pebbles by crushing. The crushing must be done very fine by means of 2 or 3 smooth crushing rollers, the rollers spaced from $^1/_4$ to $^1/_{16}$ of an inch apart, one roller on top of the other. These rollers must be kept in a very good order so that no bigger sizes of lime pebbles can pass. The pebbles should be crushed fine enough to handle the material.

3. Dipping the brick in water as soon as they are drawn from the kiln. In this way the lime is suddenly soaked and drowned. The pores of the brick are filled with lime-milk and thus closed up with lime, in this way keeping away the air from the inner brick, preventing still unsoaked lime pebbles from being soaked and so harming the brick.

4. The last way would be to overfire the lime pebbles. This means to fire the brick at as high a temperature as the lime will stand, thus burning the lime dead.

To find out which way will prove the best, I suggest the following tests: (1) Wash

enough clay to make 5–10 hand-molded brick over a 30-mesh sieve. All the material going through the sieve used to make the brick; fire those. (2) Crush the lime pebbles of your materials to 4–5 different sizes and add those different sizes to your material which must previously be washed or finely screened so that there are no other lime pebbles in the material as added to the one crushed to different sizes. After those test brick are fired and exposed to the air, it is quickly seen to which fineness you must reduce the lime pebbles so that they do no more harm to the brick. (3) Place about 50 bricks of your regular make for five minutes entirely under water until no more air is coming to the water surface, then expose the brick to the air and after a few days you will see if this helps. To do this with little expense, wheelbarrows with the brick from the kiln are placed on a double elevator, one side of the elevator going down in the water, the other side coming up, so one wheelbarrow is always under water. (4) Try to fire your brick with more heat. There are some limestones which are burned dead by certain temperatures. This way is the easiest. I met the lime trouble at a plant at Detroit, Minn., where the lime pebbles were in the worst form. The plant was making soft mud brick and used field kilns. When starting at this plant I installed one crusher with smooth roller, crushing the pebbles just to minimum size. I also increased the temperature of the firing and got excellent results, the lime troubles having disappeared.

Saves $4000 yearly by device. The Supt. *Brick and Clay Rec.*, **43**, p. 693.—The Westport Brick Co., of Baltimore reports an annual saving of $4000 by the installation of a clay cleaner. The labor of three men at $1.75 a day was saved and a granulator, a disintegrator and a rotary drier were eliminated, the clay going direct to the dry pan. A ton of coal per day at a cost of $3.40 per ton is included in the figures and only 15 h. p. is now required where 175 was necessary formerly. The actual saving in labor and coal alone is $3162.50. The Westport clay is plastic and is fired into pavers.

Wet Washing Equipment

Wants clay washing machine. Ques. and Ans. *Brick and Clay Rec.*, **43**, p. 691.—Information on a machine, a sketch and description of which is given. This shows an inclined cylinder enclosing a rotating spiral with clay and water fed in at the lower end and the coarse material being carried above the water level and falling into a chamber, the fine material all being carried off in suspension in the water. The answer gives no particular information on this type of washer.

A new clay washing device. *Brick and Clay Rec.*, **45**, p. 814.—Ernest Techen, a German, holds a patent on a device which automatically removes and separates from clays and kaolin, impurities like quartz, granular lime, pyrites, etc., and such foreign material as straw or wood.

There have been devices on the market for some time for washing clay, which consist essentially of a screw conveyor operating in a long inclined hollow drum or cylinder. The undesirable material as it settles out of the slip, is carried forward by this conveyor, a separation being thereby affected. These machines were uneconomical in their operation, the output of purified clay being too low for the amount of work represented. A complete purification was not effected, furthermore, and for this reason settling tanks were also employed to bring about further purification.

This washing device differs from the one mentioned, in that the drum or cylinder rotates while the screw is stationary. Full description is given.

A simple sand and gravel washing device. The Supt. *Brick and Clay Rec.*, **51**, p. 137. (Sketch).—The device is merely a screw conveyor set into a pipe, the whole device set on a frame at an angle sufficient to permit the water to run freely to the lower end of the water outlet. The water is admitted at the upper end, and the gravel shoveled into a hopper at the lower end.

Plastic Clay Screening

The Diesener clay cleanser. Richard G. Hoffmann, La Grange, Ill. *Clayworker*, **52**, p. 644.—Homogeneous clay is of prime importance in successful manufacture. Clays are better prepared in Europe than in the United States. Weathering is the oldest method employed for homogeneity. This allows a rapid and thorough mixing and tempering by pans, disintegrators, pug mills, or other machines. Clay is further improved by aging.

To prepare clay relatively free from impurities and one that is not tough, the pit or the common pug mill will give satisfaction. The latter is often combined with disintegrators to break up the big lumps of clay. If two or more diverse and very heterogeneous clays have to be mixed in a certain fixed ratio, the wet pan with solid bottom will give best results. A modification of the wet pan is built with a perforated bottom. This style has, under similar conditions, a larger capacity as it can be charged and emptied automatically, but its mixing properties are not as perfect as those of the solid bottom pan. Another style has been designed with several bottoms, located one above the other, but secured within the same frame and driven by the same shaft. The crude clay is fed into the uppermost pan, having numerous slots, and it is driven through these to the second bottom, having finer slots, and finally to the lowest bottom, from which it goes to the next process.

Another machine uses a pair of rollers, each consisting of strong cylindrical ribs supporting a cylindrical surface made of perforated sheet metal. The clay drops between these rollers and is forced through the slots into the rollers themselves. From the inner surface the clay is scraped off and removed into chutes. The rollers are pressed against each other by means of strong springs, which allow the rollers to increase their distance every time a stone drops between them which is too big to pass through the slots into the rollers and is consequently ejected. This machine is said to consume less power than the previous one mentioned, based on the output given. It is not adaptable to tough clays. It is claimed that the cost of maintenance with these machines is very small.

The latest in the design of pans has a solid bottom, upon which two heavy mullers run with attached scrapers so arranged that the clay is discharged automatically as soon as it is ground down to a certain size. The charging of this pan is designed to be automatic. The scraper, which defines the smallness to which pebbles, etc. shall be reduced by the mullers, throws everything back under the mullers which cannot pass between the bottom and this scraper. This can be set at $^1/_{16}$ inch from the bottom, or if more output and less fineness is wanted, the adjustment of this scraper can be changed in a few minutes.

What will the machines mentioned do on a clay that is very tough and contains pyrites? Or on clay that is very sandy and filled with pebbles of limestone? A guarantee that the prepared clay would contain nothing detrimental to making of flawless fired goods could, heretofore, only be given by the screen and only with clays in which just a few per cent of these undesirable ingredients occur, or by the washing process. To use the screen the clay must be piled up, dried, milled or ground and then screened. It is evident that in this case the impurities are still in existence in the clay, although in powdered form.

By far the best method of removing these impurities, if they are not soluble in water, is still the washing process. It is done by combining washing tanks with settling pits or with filter presses. Unfortunately the washing process removes with the impurities, the desirable quartz and feldspar sands.

In the use of the Diesener method, the clay may be worked as it comes from the bank without weathering and it does not matter if it be dry or wet. The clay is first

put through a pug mill to break it up, mix and water it. From this pug mill, the pugged clay falls into the hopper of an auger machine and comes out in the form of a bar, then passes through the DIESENER machine. If the clay is very tough and impermeable to water, it may be crushed through a roller crusher before being sent through the pug mill. The rolls of the crusher should be set apart about one inch. The pug mill may have 1 shaft and be 16 feet long or have 2 shafts and a pugging trough 6 feet long, the choice resting with the rate of slaking of the clay. The pug should have 50% greater capacity than the cleaner so that the clay soaks longer.

The auger machine issues forth a bar of clay usually about 22 x 4 inches. This should preferably be in stiff mud condition, if the clay is very plastic; or in soft mud condition if sandy. The DIESENER clay cleanser operates as follows: The bar of clay goes down an inclined plane and is pushed against the rotary disc of the cleanser and "sucked" by it through a slot (sketch). The width of the slot is adjustable down to $^1/_{16}$ inch. The stones are removed by a stone pusher or a knife that reaches from underneath into the slot. The knife must be thinner than the slot and if a slot of $^1/_{16}$ inch is used, the knife will not be strong enough to remove a stone larger in diameter than about $^1/_2$ inch or one inch. Pebbles of larger size may be ejected or crushed before the pugging process by a roller crusher with the rolls set at $^1/_2$ or $^3/_4$ inch. This would be done if the total impurities in the clay amount to only a few per cent. If many pebbles were in the clay, this crushing would decrease the output of the cleanser too much. In this case it is more economical to use 2 DIESENER machines in series, the first with a slot of $^1/_4$ inch for removing the coarse stones and the second with a slot of $^1/_{16}$ inch for the smaller impurities. As soon as the clay passes the slot, it drops in shape of shavings or snowflakes or if it is so wet as to stick to the disc, it is thrown off by an attached scraper. Six to twelve h. p. are required for the cleaner and 15 to 25 forth e auger pug mill. From 100 to 250 or more tons per day is the capacity. The knives wear out but can be made from hoop iron, the disc has to be faced one or two times a year.

Further information regarding the Diesener clay cleanser. RICHARD G. HOFFMAN. *Clayworker,* **53,** p. 448.—The power consumption is low because very little friction is developed in the clay itself The action of the rotating disc and the inclined plane upon the clay is illustrated by spreading clay over a plane surface with a knife. This is the method that the old time potters used to clean their clay, the edge of the knife tearing to pieces lumps of tough clay and extracting the stone, according to the thickness the clay is spread upon the table. Wearing on the disc is only caused by the stones which did not follow at the speed with which the clay is sucked through the slot.

It will be unanimously admitted by every practical clayworker who has seen the machine in operation that this clay cleanser has reached a degree of perfection which is unsurpassed by any other mechanical process for the same purpose under similar conditions.

Grinding Apparatus

The grinding and screening of clays. *Brick and Clay Rec.,* **43,** p. 285.—The purpose of grinding is to break up and disseminate impurities and to promote plasticity in the clay itself. Wet grinding is used where defective plasticity is found as it is the best known method for developing latent plasticity; but at the same time the method is inefficient in securing physical homogeneity. In general, dry grinding is practiced where the material is unhomogeneous naturally, and where its lack of homogeneity would cause trouble if not overcome. It is followed ordinarily by screening which establishes the limit of size of the particles and insures uniformity. Thus it is seen that the wet and dry grinding processes are more than alternative routes to the same goal. The wet treatment is slower and more costly. The roll is one of the simplest and oldest forms of grinding machines. They are used as a wet grinding machine for crushing

stony, plastic clays, and for rejecting the rocks or hard portions which are too large to fall within the angle of nip, and also as a dry grinding tool for pulverizing large quantities of nearly uniform size of grains. The most common use of rolls in this way is as a tailings grinder to finish the grinding of small particles which are partly reduced, but not enough so as to pass the screens. Differential rolls are used for grinding fine grained alluvial clay which is so plastic as to be difficult to grind in a strictly dry grinding machine like a dry pan. The small roll, about 9 inches by 2 feet long runs at approximately 500 r. p. m. while the large roll, 18 inches in diameter, makes but 150 r. p. m. When clay is fed into the machine it not only squeezes and crushes it, but also shreds and tears it apart as well. Grinds wet or dry clay.

Glacial clays are very heterogeneous in character, containing boulders, gravel, sand, etc., which have been picked up by glacial action. Their preparation offers a special problem. At one plant treating this kind of clay, a pair of conical crushing rolls, smooth surface, set one inch apart and running at 75 r. p. m. handles about nine tons per hour. In size they are 2 feet long by 12 inches at the large end and 7 inches at the small. These rolls crush the lumps of clay and smaller pebbles; and any stones that are too large for the angle of nip gradually work their way to the large end of the cones where they fall out into a wheelbarrow and are removed. The use of these rolls is chiefly for their qualities as stone separators.

The dry pan is the most commonly used machine because of its adaptability to handle the material if it would come in widely varying sizes or degrees of hardness, degrees of plasticity and in rates of feeding. The step bearing is one of the most essential features about a dry pan and must be well lubricated. Disintegrators of the hammer mill type are used some, but require dry clay and even then provision is made to steam heat the jacket of the mill in order to prevent the clay from packing in it.

After a clay has been through a pan or equivalent, and is in the form of a coarsely granulated powder, the screening still remains difficult if the moisture exceeds 5 or 6%. Caking on the screen, covering the holes, agglomerating and rolling on the surface without passing through, sticking in elevator cups, choking spouts and runways are troubles incident to dry clay screening. As the coarse particles in a ground mixture also are likely to be the hardest and also of different chemical composition from the matrix of fine aluminous material, it follows that these coarse particles are both difficult to grind finer and are the most injurious to the clay if not reground and made to blend well into the matrix. Screening is therefore necessary to establish a limit beyond which particles cannot enter the clay body except by accident. It is a very necessary part of the process of homogenization, of which grinding and tempering are the two principal steps. Piano wire screens are made adjustable by varying the pitch of the guide rods through which the wires are threaded, at both ends. When properly constructed and kept in condition this screen has large capacity, does not bind easily, requires no power and little headroom. A centrifugal screen is in use at a plant in Alfred, N. Y. It consists of a large funnel-shaped receptacle, 4 feet high with a diameter of 9 feet at its upper or large end. The screen is supported on a central shaft with spiders and suitable bearings at top and bottom and revolves with the shaft. Clay is fed into the center of the rapidly revolving cage and upon striking the bottom of the cone, begins to move up the sloping sides of the cone by centrifugal force. The fine clay passes through the perforations, while the coarse material is carried up and over the top, whence it is returned to the rolls for regrinding.

Grinding crusher rolls. The Supt. *Brick and Clay Rec.*, **50**, p. 1238.—Conical rolls used to grind the clay and separate from it pebbles and large stones, formerly were sent to the scrap heap when the stones had gouged deep enough into their surfaces to allow stones and pebbles of a troublesome size to pass through. In the place of a dis-

carded roll, whose period of service usually extended about three months, would be mounted a brand new roll. A sketch of a device is shown with which it is possible to easily grind down the surface of the rolls and thus increase their life.

Theory of roll crushers. THE SUPT. *Brick and Clay Rec.*, **51**, p. 499.—The object is to have the rolls of such a diameter and set at such a distance apart so that they will pull the lumps down through the rolls and yet not utilize excess power. If the rolls are too far apart they will not crush the material properly. On the other hand, if they are too close together they may crush the material more than is necessary, thus wasting power, or it may happen that the material will not be drawn through the rolls, but will simply slide between them and tend to stuff up the crusher (sketch). The angle of nip may have values from 0°, where the space between the rolls is as large as the lump fed, increasing upward until the angle is so large that the rolls cannot nip the fragments. The angle of nip in any case will depend for its value upon the diameter of the rolls, the diameter of the lumps fed, and distance apart at which the rolls are set. It is also affected in the following ways: It is diminished by increasing the diameter of the rolls (the space between the rolls being kept constant); by increasing the space between rolls, and by decreasing the size of lumps fed to the rolls. All relations between size of material, space between rolls, radius of rolls, and angle of nip can be expressed by a simple formula, which is derived as follows: If b = the radius of the sphere to be crushed, $a = \frac{1}{2}$ of the space between the rolls, N = the angle of nip, and r = the radius of the roll which is equal to $\frac{1}{2}$ of the diameter, then $\frac{r+a}{r+b} = \text{cosine}\,\frac{N}{2}$.

To effect a reduction, the friction F (sketch below) between the sphere and rolls must equal Ku, where K is the force of the reaction and u is the coefficient of friction. In terms of a force system as represented in the diagram, the component $F \cos x$ tends to draw the clay between the rolls, while $K \sin x$ tends to push the sphere out and hence acts in opposite direction to the force $F \cos x$. If the above forces were equal, the following equation would hold true: $F \cos x = K \sin x$ or $F = K \tan x$. From this we conclude that for the rock to pass through the rolls, u must be greater than $\tan x$ and, hence, the angle x must be less than the angle of friction.

Protecting crushing rolls from large stones. ANON. *Canadian Clayworker*, Aug. 1915, p. 11.—With a pair of smooth rolls for crushing clay which contains pebbles, trouble is sometimes caused by stones which are too large to be crushed becoming pinched against the rolls and causing undue wear on them. Grooves in the rolls are often started in this way which rapidly grow deeper until the rolls have to be ground down or discarded. Conical rolls, owing to their shape, cause all such stones to finally work toward the large end of the roll where they are free to fall out of the machine. But even with this shape of roll trouble is encountered in the prompt removal of stones which seem loath to depart until they have tarried long enough to leave their mark upon the rolls. The accompanying illustrations show a home-made contrivance for overcoming this difficulty which is in operation in a Canadian drain tile plant. A rod carries an iron point on its end which removes the stones from between the rolls. A crank turn to which is attached a connecting rod which actuates the rod with the point from left to right causing the stone picker to drag out

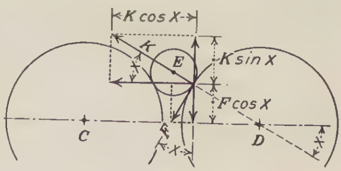


FIG. 1.

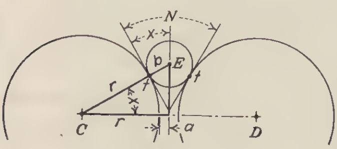


FIG. 2.

any stones which may be between the rolls but too large to be crushed. On the return stroke, the bar with the picker is lifted by means of the cam-shaped crank and is pulled from right to left passing over the stones. At the end of the stroke the picker drops down close to the rolls and the operation is repeated at the rate of about ten strokes per minute.

Improved clay disintegrator. Adv. *Clayworker*, **15**, p. 5.—A cut of a multiple squirrel cage type of disintegrator of which the interior portion revolves in opposite directions to the outside cages. This was marketed by Stedman's Foundry and Machine Works, Aurora, Ind.

Reducing costs in grinding clay. Anon. *Brick and Clay Rec.*, **53**, p. 1152.—Not sufficient consideration has been given to the ring pulverizer which has proved its merits on several plants where such advantages as higher capacity, relatively lower repair costs and less attention required, were found. In the impact type of pulverizer the rings each weigh 27 pounds, while the hammers weigh about 17 pounds apiece. A hammer is placed behind each ring and serves to dig up that which the ring rolls down, thus preventing clogging.

Grizzlies and Screens

The pros and cons of clayworking screens. Anon. *Brick and Clay Rec.*, **53**, p. 295.—Clay working screens require constant attention and often necessitate a boy at hand to keep cleaning them. Different clays require different types of screens for best work. The good and bad points of screens in general are discussed in this article. There are three types of screens used in ordinary clayworking: namely (1) the perforated metal screen, (2) the woven wire screen, and (3) the piano wire screen. The first named type is becoming increasingly popular although the woven wire screen has been used to a very great extent. The proportion of open space to solid metal in the perforated screen as now made approximates that of the wire screen which gives it an equal screening power.

To prevent decreased screening. The Supt. *Brick and Clay Rec.*, **55**, p. 1054.—Among the winter difficulties experienced in clay plants is the decreased capacity of the dry pans. In wet weather about one-fourth of the material which is poured upon the screens fails to pass through them and is returned to the dry pans, thus slowing up their capacity. To check this and force all through, 3 swinging baffle doors of sheet metal may be suspended at spaced intervals over the screen to throw and spread the dust down onto it. They should be weighted down with iron so as to prevent their swinging to such a height as to make them ineffective. By using those baffle doors, the dust is thrown from the buckets against the first one and then falls down and spreads upon the screen. It will then roll downward and strike another baffle door and so on, until it finally reaches the tailing spout. However, by the time it reaches this point the dust that is sufficiently ground will have passed through the screens. The doors should be bent to a slight "V" shape to spread the dust that naturally tends to follow the central channel in its course down the screen.

Drying by Storage

The advantages of clay storage and the description of a successful installation. F. H. Riddle. *Clayworker*, **69**, p. 32.—The very complete system installed at the Gladding McBean & Co.'s plant is described in detail in a five-page article.

Economic methods of heating clay storage sheds. Cleve Hartzell, Supt., Whitehall Drain Tile Co. *Clayworker*, **69**, p. 544.—In this article the author outlines a satisfactory and inexpensive system of thawing and drying frozen clays and shales.

Waste heat is taken from the kiln and circulated in 15-inch sewer pipes that are built below the floor of the storage shed.

The preparation of clays, mining, drying and proper mixing. W. W. SWENGEL. *Clayworker*, **68**, p. 235.—Often the capacity of the plant is curtailed, owing to the damp material. By the drying of the clay mechanically, a maximum output is assured throughout the entire year, where formerly the capacity was reduced in winter and wet seasons. It is important in many cases, to have a clay drier for the purpose of drying damp clay, so as to be able to eliminate pebbles and to enable the plant to make proper and exact mixtures.

The importance of clay storage. A. S. PLATT, Van Meter, Ia. *Clayworker*, **75**, p. 358.—A general discussion of the advantages of clay storage.

The storing and handling of raw clays. T. W. GARVE. *Jour. Amer. Ceram. Soc.*, **3** [4], 266.—Twenty pages of description and drawings of storage sheds and their operation.

Clay storage. H. P. ROBBINS, Adv. Mgr., Weller Mfg. Co. *Brick and Clay Rec.*, **44**, p. 1398.—Storage and conveyor systems worked out by this Company are illustrated and described. See also article by ROBBINS in *Brick and Clay Rec.*, **46**, p. 52.

Storing and weathering clay. QUES. AND ANS. *Brick and Clay Rec.*, **47**, p. 758.—NEBRASKA.—What are advantages of storage?

ANS.—Mixing, weathering, etc. Where clay contains any considerable percentage of lime, the weathering process improves it, and cases are known where the installation of a storage system with a free circulation of air through the clay has done away with a tendency toward efflorescence and has, in this way, saved the expense of using corrective chemicals.

Winter grinding and screening. ERNEST W. KNAPP, Supt., Sun Brick Co., Toronto. *Brick and Clay Rec.*, **50**, p. 635.—Economical use of storage sheds and suggestions for all year round operation.

Rotary Driers

Offers improved clay drier that costs less and saves fuel. *Clayworker*, **68**, p. 246.—Invention of W. W. SWENGEL, Bloomsburg, Pa. Three superimposed rotating cylinders, all encased in brickwork chamber. It is claimed to cost less to install and saves 30 to 40% in fuel.

New method for drying clay. *Ceramic Abstracts*, **1** [3], 85 (*Jour. Amer. Ceram. Soc.*, **5**).—Three pottery plants at Devon and Cornwall are now using a new method for drying clays in which two metal drums are employed, one enclosed in the other. The inner drum is driven by mechanical means and while revolving, steam enters in at a few degrees above the temperature of boiling water. The clay is passed into the outer drum and comes into contact with the inner drum as it revolves, filled with steam. The water in the clay is evaporated and the clay dried quickly, the process being one measured in minutes.

On the drying of raw clay. From the *British Clayworker*. (*Brick and Clay Rec.*, **54**, p. 518.) QUES.—What is the most efficient and economical way to dry from 50 to 100 tons of fresh dug plastic clay in a day of nine to ten hours?

ANS.—A cylindrical drier is preferable on account of the large amount of labor it saves. Whether the drier should be vertical and stationary or inclined and rotary depends on the nature of the clay and on its properties during the drying. A plastic clay with 16% water has been dried for 20 cents per ton. The question as to the desirability or otherwise of drying a plastic clay in order to work by a semi-dry process is a very different one; in most cases it would be unwise to endeavor to do so.

Drying plants for clay and clay products. R. GRUNHUT. *Trans. Eng. Ceram.*

Soc., **9**, p. 227.—In a rotary drier an ejector grate produces the necessary hot air and presses it through the drum, either on the counter-current principle, or, preferably, on the continuous-current method, as in the latter case the wettest clay meets the hottest air and cannot lose its plasticity owing to overheating. Rotary drums show a high degree of efficiency. Six to 9 pounds of water can be evaporated with 1 pound of coal, and one man can look after 6 and more drums. The wear is insignificant, and very little power is required to run even the largest drums. Below you will find figures giving the efficiency of a counter-current drum. Average temperature of shell and furnace not over 150°F. Material was tested for specific heat. Coal tested calorifically.

Amount of coal burned per hour	400 lbs.
Amount of moisture in coal	10%
Calorific value of coal	13,000 B.t.u.
Material dried—clayey sand	
Amount of wet material per hour	45,000 lbs.
Amount of dry material per hour	42,750 lbs.
Specific heat of material	0.21°F
Moisture in material	5%
Temperature of air and materials	60°F
Temperature of dried material	224°F

Recapitulation of computations which are given:

	%
Loss by excess temperature of material	2.5
Loss by heat in exhaust gases	6.5
Loss by imperfect combustion	0.7
Loss by radiation and other causes	4.5
Drier efficiency	85.8

Centrifugal extractors. V. Filter presses. J. W. Mellor. *Trans. Eng. Ceram. Soc.*, **6**, p. 171.—In the hydro- or centrifugal extractor the rapid rotation of a perforated cage containing the material drives the fluid portions through the walls of the cage and leaves the solid material behind. The process works well with fibrous materials and granular substances, but not with finely divided substances. It was found that the clay slip forms a hard crust on the walls of the perforated cage. The crust is not permeable enough to permit the passage of the water from the slip in the interior of the cage.

Later: There is a recent patent for drying china clay, in which the principle of the centrifugal extractor has been applied in a very ingenious way. The clay slip runs through the center of a long cylinder with solid walls. The cylinder is rotated rapidly and solid clay collects on the walls of the cylinder, and water, free from clay, flows from the opposite end. When the exit water appears turbid the cylinder is emptied and again set to work.

Limestone—General

Carbonate of lime in clays. The Supt. *Brick and Clay Rec.*, **50**, p. 1055.—It comes usually in grains or small-sized pebbles, but often causes serious trouble by appearing in large-sized pebbles. Lime is a powerful flux and very sudden in action, it is exceedingly dangerous, and clays containing a large amount of it cannot be vitrified. Calcium sulphate will form if pyrites are also in the clay. Lime will tend to make a clay work and dry more easily. If a limey clay is treated with acid (which is practical only in small quantities) and the lime removed from the clay, the original red firing color will be restored. There is only one means of combating the lime menace in clays

and that is to grind the pebbles to such a small size that they are incapable of causing very much trouble. A porosity curve is also of great help in determining the best method of handling lime. If the chart shows a very abrupt drop in porosity between certain temperatures very close together, it is more than probable that lime is present and is an indication that the kiln should be held at this point until all of the gas from the lime is expelled. A quantitative test for lime may be made by boiling a sample of the clay in a diluted solution of HCl and filtering the liquid through a filter paper. Add to the clear solution thus obtained some ammonium hydroxide, which will cause a reddish precipitate. Filter off again and add to the clear hot liquid some ammonium oxalate. If lime is present, a white precipitate will result.

Limestone and "popping." THE SUPT. *Brick and Clay Rec.*, **51**, p. 499.—Clays which "pop" after firing in up- or down-draft kilns, often will not "pop" when fired in a continuous kiln, especially if the kiln has no advanced heating flue. The sulphur gases of the continuous kiln convert the lime into calcium sulphate which does not hydrate. Lime in an extremely fine condition or as a constituent of a mineral which dissociates at kiln temperatures, is extremely troublesome in the firing. It does not act as a flux at low temperatures nor until dissociation takes place and then it seems to act suddenly and completely. Some limestones, likely because they are earthy or dolomitic, do not cause "popping." Shale beds near Buffalo, N. Y. and Toronto, Canada, have interstratified streaks of limestone 6 to 12 inches thick, yet the ware made from this shale does not "pop."

The function of lime in clays. A. V. BLEININGER. *Clayworker*, **54**, p. 156.—The effect of lime carbonate in clay depends upon the composition of the lime compound and secondly upon its fineness. Some limes slake rapidly, others very slowly or not at all, an increase in magnesium content tending to decrease slaking action.

The effect of coarse lime particles in the clay after burning is too well known to need description. We know that they will swell and burst the ware as soon as water or steam from the air reaches them. It is interesting in this connection to note that if the fired clay ware is dipped into water or taken to a very moist room right after it has been taken from the kiln, while still warm, the destructive effect of the lime is very much less evident, in fact, may become insignificant. It is the practice in some European districts to lower a wheelbarrow of bricks, containing lime, into a pit filled with water as soon as it is wheeled from the kiln. The reason why lime slaked rapidly with an excess of water will not burst the ware (unless the particles are too large) is to be sought in the fact that with plenty of water at hand the quicklime will not expand as much as it does when the water absorption is more gradual.

Fine-grained lime carbonate in clay during drying acts much like sand, making such clays very easy to dry. In firing up to a certain temperature, it will cause the clay to remain porous, and if much of it is present, it will raise the heat required, considerably. As soon as a certain temperature, which depends upon the clay, has been exceeded, however, the lime becomes very active, causing the clay to vitrify and melt quite suddenly. Clays high in fine grained lime cannot be commercially fired to vitrification, as it is practically impossible to control the heat sufficiently for this purpose. An originally red firing clay by the admixture of fine lime carbonate becomes buff and, if vitrified, green.

Our clays contain frequently both coarse and fine lime at the same time and while we can eliminate the large limestone pebbles quite easily, this experiment is to determine how fine the particles smaller than the size of a pea must be crushed. He used but one red firing clay and to one-half of the bodies he added 10% of lime particles and to the other half 20%. Nine sizes of particles were added in each case, 6–8, 8–10, 10–14, 14–18, 18–20, 20–40, 40–60, 60–80, 80–100 mesh. These 18 bodies were fired to 3

different temperatures, cone 08, 06, and 04. He noted the water of plasticity in each case, also the dry, fired and total shrinkage. He concluded that more water is required to temper the mixtures, the finer the size of the crushed limestone. No significant changes are observed as regards the drying shrinkage. In all 3 of the firings, especially at the higher two temperatures, both the firing and the total shrinkage decrease as the size of the lime particles becomes smaller. The bricklets were placed in a damp closet for a week, then photographed. With 10% limestone no evident damage has resulted from the 20–40 mesh size, but with 20% the lime must be finer, 40–60 mesh. In Fig. 2 representing the same test pieces fired at a higher temperature, cone 06, we observe at once that the injury caused by the lime is not as pronounced as it was at the lower temperature. In both firings the color of the clay remained red, although it naturally was somewhat lighter than that of the clay itself. No tendency toward a buff color is observed, thus showing that the lime, in order to change the color of ferric oxide from red to a cream color, must be much finer than the sizes employed here. It seems then, that in order to assure the prevention of mechanical destruction and pitting of the fired ware, the lime particles in the raw clay must be reduced in size finer than 40 mesh. If the appearance of small specks is undesirable, it would be necessary to grind the lime finer than 60 mesh. The harder the clay is fired the coarser may the lime particles be.

As to the removal of lime from raw clay, it is evident that as much of the lime pebbles as possible should be eliminated before crushing. Following this, the clay must be ground as fine as possible. The ideal preparation would be the removal of the pebbles by means of some separating device, the drying of the clay in a rotary drier, pulverization in a disintegrator, and screening through a close sieve, after which the material would be ready for pugging.

General Discussion

Richard G. Hoffman, La Grange, Ill.—I come from a country (Germany) where they have made tremendous endeavors to get rid of lime because they cannot move, as they do in this country, to where they can get clay that is pure. They have to stay in the neighborhood of big cities and get that trade and do as best they can. We have a dozen different machines that answer fairly well the purpose of mechanically purifying clay. If the lime is in the shape of dust, or fine as flour, it is impossible to get it out, not even by washing or slumming. But if the lime happens to occur in size of grains of more than $^1/_{16}$ inch, and especially if it is in combination with a harder material, like slate, it is not so difficult to get it out, and we have had those machines constructed and in actual, practical operation for a few years which will take out lime pebbles down to about the size of a pin head and do it on a commercial scale. A ton of clay purified by mechanical process would cost from one to four or more cents a ton, according to conditions.

The behavior of granular limestone in burned clay. Charles F. Binns and Merle A. Coats. *Trans. Amer. Ceram. Soc.*, **14**, p. 218.—Bleininger's work is referred to, but this work has been done quite independently of his investigation. The object of the investigation was to determine (1) the smallest size of grain at which the limestone was dangerous, (2) the amount of lime which could be present without causing harm, (3) the effect of fire in destroying the power of the lime, and (4) the possibility of treating the ware after firing so as to render the lime harmless.

An ordinary red-firing-brick clay was chosen as the body. This happened to be a surface clay of slaking character from the carboniferous horizon. Used alone it fired to a clear red and to a common brick density at about cone 01. A gray limestone used as a building stone was crushed and graded in the following sizes: 8–12, 12–20, 20–36, 36–55 mesh. Of the largest grain limestone 8–12 mesh, amounts of 1, 3, 5, and 8%,

respectively, were added to the clay. Of each mixture 9 small bricks were made by the plastic process, using a wooden mold. Three of the bricks were fired at each of the cones 06, 03, and 01 in 18 hours. The same procedure was followed in the case of the 12–20 mesh. In order to test the effect of the German practice of soaking brick containing lime, one brick of each series was immersed in water for 30 seconds and another brick was soaked to saturation immediately on being drawn from the kiln. The remaining brick of the trio was left dry. Each group of 36 bricks was then arranged in order on a shelf in the laboratory, without further treatment, and photographs taken at ten-day intervals.

There is no serious damage, at 20 days, except spalls on the surface until the 5% lime is reached. Of these the dry and dipped brick at the lower fires show signs of a weakened structure. Of the 8% series all the dry and dipped brick are crumbling, some of them being completely destroyed. The damage is rather less in the higher burn. None of the soaked brick, even with the highest content of lime, show any damage except the white spots on the surface where the lime grains are exposed. After 10 days more the spalling is worse in the members with the smaller content of lime and the disintegration of those with 5 or 8% has proceeded further. The soaked brick are still sound. Another 10 days show no change except that the disintegration which had been before noted had gone further. The soaked brick are still intact. In the series of 12–20 mesh particles practically the same phenomena are observed but in a less marked degree. It should be noted that the dipping for 30 seconds has no effect at all. Sometimes the dry brick give way first and sometimes those that were dipped.

The second series was made up with 20–36 grain limestone, percentages of 5, 8, 12, and 15 were used and 6 bricks only were set up, one at each fire being dry, the other soaked. Also a similar series with 36–55 grain limestone. After standing for 30 days no marked change could be observed. A slight disintegration shows on the edges of the 15% dry brick at cone 01, this being the first occasion in which the higher fire is less effective than the lower. A possible explanation of this is that the larger percentage of lime has produced an open and more elastic structure at the lower fire and this has served to take up the expansion of the grains. In the higher fire the body has become more resistant and, hence, it gives way under pressure. It is probable that all the 15% dry brick will eventually fail though the soaked members still appear sound. In the group containing 36–55 lime there has not yet appeared any disintegrating effect.

It appears from this study: (1) That lime grains as large as would be rejected by a 12-mesh sieve are objectionable even in small quantities, for though the brick may not be ruptured there is apt to be an unsightly spalling of the surface. (2) Lime grains which pass 20 mesh are admissible up to 3 per cent of the weight of clay, but here also there is a likelihood of surface damage. (3) That to be entirely safe the lime grains must be ground to pass a 36-mesh sieve, and that lime as fine as this may be present in a proportion as high as 12%. (4) That the danger of rupture from lime grains may be almost completely avoided by a saturation of the brick on being drawn from the kiln. This saturation appears to be more effective if the brick are in a very porous condition. Some of the members which were fired to a greater density exhibit some surface spalling, but brick were made and soaked ten months ago and are whole yet.

It has been found that a given quantity of granulated lime when wetted will expand suddenly and then shrink slightly though not to its former bulk. The same quantity of lime when exposed to the air will swell slowly though it does not reach the amount of expansion of the wetted lime.

In the experiment illustrated the same weight of freshly burned granulated lime was placed in each of two glass tubes and a dark line was marked level with the top of the lime. The tubes were set on blocks of plaster for support. Into the tube marked

"wet," sufficient distilled water was poured to thoroughly slake the lime. The tube marked "dry" was not wetted but placed in a moist atmosphere. The expansion of the wet lime was sudden and was followed by a slight shrinkage of the mass. The dry lime slowly expanded but did not reach the volume of the other. It seems as though the sudden and complete saturation of the lime caused it to deliver a quick blow, like that of a hammer, upon the surrounding clay and that after this blow, it had no further power. The dry lime on the other hand, exerts a slow and increasing pressure which under the proper conditions, is irresistible. Whether this explanation be the true one or not, it seems to present fewer difficulties than any other which has appeared.

Discussion.—PROF. BLEININGER: The authorities on lime seem to agree that the lump expansion of lime in the presence of a larger amount is smaller than in the case of a smaller volume of water. This is all I know about it, and I am very much pleased that PROF. BINNS has done this work. I have been attending for several years, the meetings of the National Lime Association and I find that they are up against the same propositions that we are with clays. Some of their evidence is, on the surface, contradictory. (Refer to BLEININGER'S paper where he states that lime on being treated with an abundance of water does not swell as much as the lime which draws the moisture from the air.)

PROF. ORTON: States instance of where pebbles that themselves were only 5% lime, caused ultimate destruction of the brick.

DR. RIES: One of his students checks results of BINNS and COATS except action was more violent.

DISCUSSION ON "EUROPEAN SILICA REFRACTORIES"[1]

M. C. BOOZE:[2] The author does not give porosity data on any of the products tested. In view of the results obtained by Harvey[3] on the resistance of silica refractories to abrasion these would have been interesting.

In the interpretation of the results which Cole obtained on the two silica cements tested, a fusion point of cone 19 for one is attributed to the fact that the sample was finely ground, 80% passing 200-mesh. It seemed hardly possible for fine grinding alone to reduce the fusion point from cone 28 which is about the average of these cements to cone 19 and to check this up a test was made using in one case a commercial silica cement 38% of which passed 200-mesh, and in the second case the same cement ground down so that it would *all* pass 200-mesh. The fusion point of the first was cone 28 and of the second, or finely ground sample, cone 26.

As far as the writer is able to judge from personal observations, there are three major differences between English and American silica brick practice.

1. In English plants the practice is followed of blending two or more types of silica-bearing rock. One of these is comparatively soft and apparently reduces more readily than the others giving the effect of grading as to grain size in the ground mud.

---

[1] S. S. Cole, *Jour. Amer. Ceram. Soc.*, **8** [1], 55–58 (1925).

[2] Mellon Institute, Pittsburgh, Pa.

[3] *Jour. Amer. Ceram. Soc.*, **7** [12], 895–906 (1924).

2. The grind is on the whole finer for both brick and shapes than is the practice in this country. Deep pans are used and the grinding is accomplished in from 30 minutes to $1^1/_4$ hours. Many of the plants here grind each batch in from 15 to 20 minutes. The practice of varying the grind according to the use for which they are sold is also followed in England to some extent. On open-hearth roof brick an exceptionally coarse grind has been observed.

3. Although there are at least two plants firing silica brick as hard as is customary here, this is not general. The kilns are capable of withstanding the necessary temperatures for satisfactory firing, many of them being silica lined, while in this country the side walls and crown are usually built of clay brick.

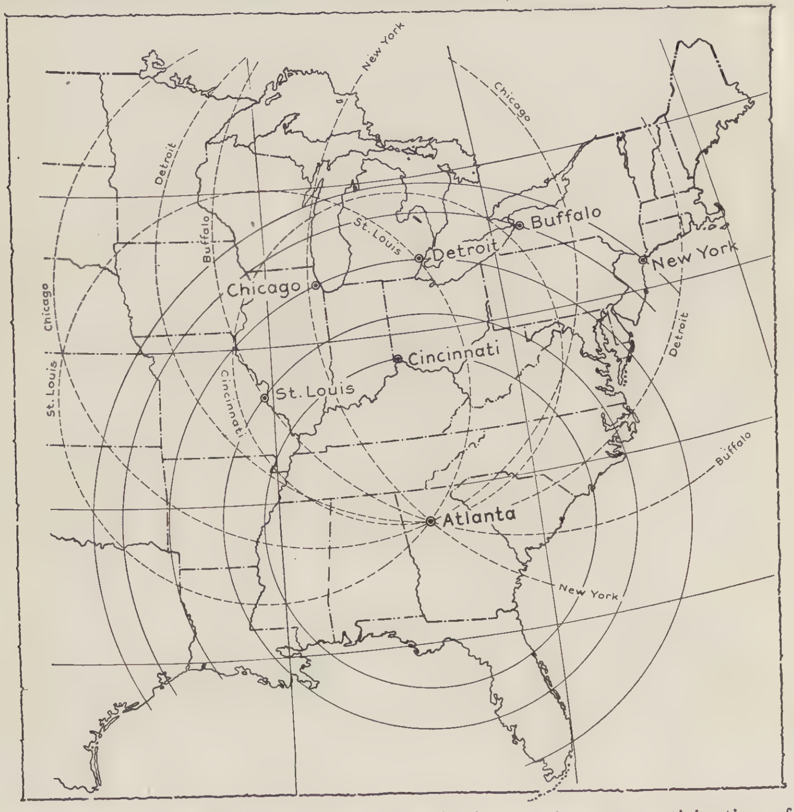
The use of fine grinds, blends of quartzites of different hardness, and the close attention which is given to the surface finish all tend to produce a density and hardness in the English product which is desirable for use in the coking chambers of by-product ovens.

While less is known of the procedure followed in Germany, at one plant which was visited there the blending of quartzites, fine grinding and soft firing which was noted at the English plants was also observed.

ACTIVITIES OF THE SOCIETY

OUR NEXT ANNUAL MEETING

The hustlers of the Southern States join the ceramists of Georgia in a hearty welcome to American ceramists to meet in Atlanta next February the week of the 8th. They have many ceramic things to show. Those who have already seen the Georgia resources



and have been favored by the southern hospitality are in great anticipation of the pleasant and instructive week the SOCIETY members and friends will have in Atlanta next February. Things unusual, things useful, things instructive and things very pleasant await us at the hands of our Georgian members.

NEW MEMBERS RECEIVED FROM FEBRUARY 21[1] TO MARCH 15

PERSONAL

Clifford L. Ach, 314 Produce Bldg., Los Angeles, Calif. Manager, Pfaltz & Bauer.
Neslon D. Booth, Superintendent, Naugatuck Valley Crucible Co., Shelton, Conn.
Albert M. Cleverley, Falkirk Iron Co. Ltd., Falkirk, Scotland.

[1] Names of members received from Feb. 16–20 (during the Annual Meeting) appeared in the March *Bulletin*.

Wilbur C. Fisk, Logan, Ohio. President, Hocking Valley Products Co.

Charles R. Fletcher, Blasdell, N. Y. Sales Manager, The Exolon Co.

Carl H. Geister, Mellon Institute, Pittsburgh, Pa.

William A. Harty, The Exolon Co., Blasdell, N. Y. President and General Manager.

E. M. Hernandeth, 4419 Victorine St., Los Angeles, Calif. Glaze Foreman, California Clay Products Co., South Gate, Calif.

Ernest W. Huttig, New Brighton, Pa. Ceramic Engineer, Sherwood Bros. Co.

Charles C. Leigh, 6514 Van Dyke St., Tacony, Pa. Ceramic Chemist, Gillinder & Sons, Inc.

Virgil E. Ready, Los Angeles Gas & Electric Co., 810 S. Flower St., Los Angeles, Calif. Efficiency Engineer.

Oliver E. Schumacher, 717 Crenshaw Blvd., Los Angeles, Calif.

William D. Turner, 1111 State St., Rolla, Mo. Head, Department of Chemistry, University of Missouri.

Julius F. Weinhold, 48 Van Sicklen Ave., Brooklyn, N. Y. Assistant Engineer, Refractory Brickwork Dept., Alphons Custodis Chimney Const. Co., New York City.

CORPORATIONS

Cross Gas Co., Lovell, Wyo. R. E. Richardson. Vice-President.

General Motors Research Corp., Box 745, Dayton, Ohio.

Holcroft & Co., 6545 Epworth Blvd., Detroit, Mich. John T. Jans.

Membership Workers' Record

	Personal	Corporation
L. C. Hewitt	1	
B. Mifflin Hood	1	
R. B. Keeler	2	
H. J. Knollman	2	
E. Ward Tillotson	1	
Office	7	3
Total	14	3

REPORT OF THE COMMITTEE ON ENAMELING FURNACES FOR WET PROCESS CAST IRON ENAMELS

The Committee on Enameling Furnaces for Wet Process Cast Iron Enamels, in proceeding with its work, prepared a questionnaire which it was hoped would cover the main points on which information was desired for the various types of furnaces in use in this branch of the enameling industry.

Separate questionnaires on coal fired, oil fired, gas fired, and electric furnaces were made up and were sent to about fifty different enameling firms, together with a letter explaining the purpose of our gathering this information.

Twelve replies, covering fourteen different furnaces were received. The information received in these questionnaires, supplemented by somewhat less complete information supplied by *Ceramic Industry,* has been compiled in tabular form, and is presented herewith.

Tabulation of Data

It is to be regretted that there are several quite evident inaccuracies in the table of data, but the data have been tabulated on the basis of the information supplied to the committee.

The fuel cost per operating hour has been calculated by dividing the "fuel cost per 24 hours" by the "number of operating hours per day."

Each firm submitting a questionnaire was asked for "pounds of iron fired per hour (one coat)," for "pounds of iron fired per month (one coat)," and for "fuel cost per month."

The fuel cost per pound of iron fired on the hourly basis was calculated as the quotient of the fuel cost per operating hour divided by the pounds of iron fired per hour, just as the fuel cost per pound of iron fired on the monthly basis was calculated as the quotient of the fuel cost per month divided by the pounds of iron fired per month.

The item of "man-hours per month" is the product of the number of operating hours per month and the number of men working on the furnace.

Pounds production (one coat) per man hour is the quotient of pounds of iron fired per month (one coat) divided by the man-hours per month.

All other items as given in the table are as listed in the questionnaires.

Discussion of Data

All the furnaces upon which information was obtained were used for the enameling of stove parts, but no information is given except on furnaces D and I, as to whether the work was light gas stove castings or heavy coal stove castings. On furnaces D and I, the lower value figures on pounds of iron fired are for light castings, and the larger value for heavy castings.

All furnaces with the exception of furnace D are insulated with either Sil-O-Cel or cork brick, but no information is at hand as to the amount or extent of the insulation.

Plant A reports using 5000 pounds of coal per day on a clay muffle and 2500 pounds per day on a carborundum muffle of the same size and operating at the same temperature. However it should also be noted that Plant C uses 1350 pounds of coal on a 10′ x 48″ clay muffle at 1300°F while Plant D uses over 2000 pounds on a carborundum muffle of the same size at 1200–1240°F. Of course the furnace at Plant D is not insulated, but there is a wide difference between 50% *less* coal on a carborundum muffle in Plant A and 50% *more* coal in Plant D than is used on clay muffles of the same size.

Likewise Plant M uses 336 gallons of oil per day on a 10′ x 54″ furnace at 1325°F and Plant N uses only 172 gallons of oil on a 10′ x 52″ furnace at 1300°F. However Plant M has a production of 725 pounds of enameled castings per hour, as opposed to N's 275 pounds, and operates for 24 hours instead of $22^1/_2$.

Such wide divergence in data makes it extremely difficult to make any comparisons between furnaces in this report, so the data will simply be presented in the form in which it is available, with the hope that furnace men and plant engineers will themselves be able to compare to their own satisfaction the behavior of furnaces in which they are interested.

Committee
- J. E. Hansen—*Chm.*
- L. A. Adams
- L. D. Bridge
- H. D. Cushman
- W. C. Lindemann
- F. G. Roberts
- R. D. Wells

COMMITTEE ON CAST IRON ENAMELING FURNACES (Wet Process)

Furnaces Data

Plant	Size of muffle	Muffle material	Fuel	Fired	Temp., °F.	Time of firing First coat	Time of firing Second coat	Heats per hour	Fuel per 24 hours	Cost per unit	Fuel cost per day	Hours operated per day	Fuel cost per operating hour	Pounds iron fired per hour, one coat	Fuel cost per pound iron fired hourly basis	Pounds iron fired per month, one coat	Fuel cost per month	Fuel cost per pound iron fired, monthly basis	Number of men on furnace	Man hours per month	Pounds production one coat per man-hour	Type and weight of firing bars	Type of fork	Maintenance cost	Remarks
A1	11½' x 54"	Clay Flat	Coal	Direct	1600	20	12–18	2.6–3	5000	$5.70	$14.23	21½	0.663	140	0.0047	70,000	$357.25	0.0051	2	1000	70	Cast Iron 200	Hand	400.00	Shut down for repairs about every six months
A2	11½' x 54"	Carb. Flat	Coal	Direct	1600	20	12–18	2.6–3	2500	5.70	7.12	21½	.331	140	.00236	70,000	178.63	.00255	2	1000	70	Cast Iron 200	Hand	None 9 months	
B1	10' x 42"	Clay Arch	Coal	Direct	1350 1450	15	8	3–4	1900	7.00	6.65	21½	.309	229	.00135	120,000	126.00	.00105	2	946	128	Therm. 77	Hand Mech.	175.00	Two years' service without repairs
B2	10' x 31"	Clay Arch	Coal	Direct	1350 1450	15	8	3–4	1700	7.00	5.95	21½	.276	180	.00153	70,000	115.00	.00165	2	964	74	Nichrome 30	Hand Mech.	150.00	Two years' service without repairs
C	10' x 48"	Clay Flat	Coal	Direct	1300	10	10	3½	1350	7.04	4.75	24	.198	333	.00059	200,000	105.50	.00053	1	500	400	Therm. 75	Hand Balanced	250.00	Six months' service without repairs, old type furnaces—about to be replaced, underground flues
D	10' x 48"	Carb. Flat	Coal	Direct	1200 1240	10–12	10–12	4½	2000 2200	5.79	6.27	10½	.597	325 475	....	80,000 133,000	180.00	....	2	586	136 222	Therm. 75 Calloy 90	Speed	150.00	One shutdown to re-level hearth One shutdown to clean flues (Both in one year)
E	....	Carb.	Coal	Direct	1300	..	...	...	3000	7.50	11.25	24	.470	125 lbs. per load	....	....	....	....	.	...	...	....	....	100.00	
F	9' x 42"	Clay Arch	Oil	Low Press. Rockwell	1150	20	15	3–4	84 gal.	.06	5.04	24	.210	340	.00062	90,000	152.00	.0008	1	600	300	Chromel 50	Hand Balanced	100.00	About two years' service without repairs
G	9' x 42"	Carb. "V" Bottom	Oil	Low Press. Rockwell	1300	..	...	...	168 gal.	.07	11.78	21	.560	577	.00097	261,000	240.00	.00092	1	453	576	Calloy "B" 60	Hand Balanced	23.13	Production and cost data is average over four months
H	8' x 36" grate area 6' x 36"	One Clay One Carb. Arch	Oil	Low Press. Wayne	1300	7–8	5–6	5	180 gal.	.0483	8.69	24	.361	200	.00181	66,811	205.00	.00307	1	626	107	Therm. 60	Hand Balanced	100.00	Production and cost data is average over one year
I	10' x 54"	Carb. Flat	Oil	Low Press. Sur. Comb.	1275	8–12	8	6–8	102 gal.	.045	4.59	24	.191	500 875	....	310,000 520,000	....	....	1	624	495 835	Nichrome 80	Speed	None 1st year	High production figure is on heavy coal stove castings. Low production figure is on light gas stove castings. This furnace replaced an intermittent gas fired furnace costing $0.75 per hour for fuel with only one-half the production. Two men, but no speed fork used on old furnace
J	10' x 48"	Clay Flat	Oil	High Press. Best	1300	7	6	8	96 gal.	.0475	4.56	24	.190	...	....	....	....	....	2	...	...	Therm. 80	Hand Balanced	....	
K	9½' x 54"	Carb. "V" Bottom	Oil	Low Press. Hauck	1400	10	11–12	5–6	140 gal.	.0616	8.62	24	.359	...	....	99,000	260.00	.00263	2	600	165	Therm. 73	Speed	New Furnace	
L	10' x 54"	Carb.	Oil	Low Press. Sur. Comb.	1300	..	...	...	120 gal.	.062	7.44	24	.310	55 lbs. per load	....	....	....	....	.	...	...	....	....	....	
M	10' x 54"	Carb.	Oil	Low Press. Venturi	1325	7	10	...	336 gal.	.0592	20.00	24	.830	725	.00114	....	....	....	.	...	...	....	....	260.00	
N	10' x 52"	Carb.	Oil	Low Press. Anthony	1300	..	...	...	172 gal.	.0638	10.95	22½	.487	275	.00177	....	....	....	.	...	...	....	....	None 2 years	
O	12' x 66"	Carb.	Oil	Low Press.	1250	..	...	...	96 gal.	.06	5.75	24	.240	270	.00089	....	....	....	.	...	...	....	....	None 10 months	
P	10⅔' x 42"	Carb. Arch	Natural Gas	Low Press. Sur. Comb.	1300	15	12	5	25,000 cu. ft.	1.00 per M. up to 500,000 0.60 per M. over 500,000	...	9–16	...	245	....	52,500	626.00	.0119	1	214	245	Chromel 42	Hand Balanced	....	
Q	8' x 48"	Ribbon Re- Resistor	Electric		1700	7–9	7–9	6–8	....	0.018 per k. w. h.	...	..	...	...	....	22,000	700.00 800.00	.0341 Basis of $750.00 per month	2	...	...	Nichrome Therm. 160	Speed	None 16 months	

Back of
Foldout
Not Imaged

REPORT OF THE DIVISION COMMITTEE ON STANDARDS, 1924–1925, ENAMEL DIVISION

It seemed quite evident from the discussions which took place in connection with the report of the committee for 1923–24 that the Division was more particularly interested in the standardization of methods of control than in tests of product. Therefore the work of the year being covered was thus confined.

Unfortunately circumstances in connection with the various members of the Committees have been such that but little research work has been accomplished, and there has appeared in the literature but little that could form the basis of a study on the part of the Committee. What has been accomplished may well be considered under several headings.

Enamel Raw Materials In view of the fact that the preliminary work of last year on clays and feldspar was done by H. C. Arnold, he was re-assigned the same duties. Early in the year he found it necessary to resign as a member of the Committee and the Chairman of the Division was unable to find another to take his place. Hence nothing is ready to report along this line.

There is being carried on by one member of the Committee a comparison of over 20 clays with reference to their relative merit in suspending enamels. This work is not yet far enough along to warrant any statements but it is hoped that the data at hand and to follow will be of value in pointing to a method of predetermining the fitness of a given clay.

Flotation of Enamels The problem that has received more attention than any other has to do with the suspension of enamel by clay. A survey of the literature in terms of the colloid theory has been made and forms the basis of a paper on the present program. Considerable work had been done by W. N. Harrison who is at the Bureau of Standards and a progress report of his efforts is also on the program. Considerable study and some experimental work has been done along the line of the application of the conception of mobility and yield point to enamel slips. Nothing is ready for presentation, however.

Opacity of Enamel It was suggested by the Committee of last year that the methods used for studying color and covering power of paints might have an application in connection with color and opacity of enamels. Accordingly tests with the Pfund Colorimeter are being conducted at the Bureau of Standards. Further work is to be done on the problem before a complete report can be made.

Committee { Emerson Poste, *Chm.*
R. D. Cooke
M. E. Manson
W. N. Harrison

ANNUAL REPORT OF THE REFRACTORIES DIVISION

During the year 1924 there were published in Volume 7 of the *Journal* thirty-two articles dealing with the subject of refractories and including in all 306 pages or one-third of the total volume which comprised 920 pages. Most of these articles are contributions by members of the Refractories Division.

During the year, the bibliographies on silica and magnesite were distributed in completed form. The bibliography on clay refractories was compiled in subject form without abstracts. A bibliography on chrome refractories has been started. It yet remains to prepare a bibliography on special refractories, to include the diversified materials not included in the other bibliographies.

The divisional sessions at the Columbus Meeting were longer than had ever been attempted before. In addition to the three half day sessions of the Refractories Division alone, there was also a joint symposium with the Glass Division lasting two half days and a symposium on refractories for foundry practice which lasted a half day. The latter was attended by members of the American Foundrymen's Association. This symposium was under the auspices of the United States Bureau of Mines and was the third of the series of consumers' sessions. Several papers of great value were read.

On the whole, the meeting was a success from the point of view of this Division. The program was full of interest and value; the authors were carefully chosen; and the papers well prepared. The program committee is to be congratulated for the success which crowned its efforts. The announcement board system for the simultaneous meetings was in successful operation and greatly assisted those in attendance. Some embarrassment was caused by deviating from the printed schedule. These deviations were caused by circumstances beyond the control of the officers and are to be regretted, but was the best which could be done under the circumstances. It yet remains to evolve a method to prevent speakers from overrunning their time and to make the most of the time for discussion. In view of the cost of these meetings and the expense of time and money involved to those attending, it will be seen that this is a subject deserving serious thought.

At the business sessions the following resolutions were introduced and adopted:

1. "That the Division stand in silence for one minute in memory of our late member, Raymond Miller Howe."

2. "That as far as possible, the program committee secure preprints of the papers to be presented at the next meeting."

3. "That the Division go on record as favoring the continuance of the stenographic service."

4. "That no paper be given a place on the future programs unless an abstract is submitted to the program committee."

It was moved, seconded, and voted:

1. "That the secretary be instructed to convey to the local committees and to the boys of the Ceramic School the appreciation of the Division for their services."

2. "That a vote of thanks be given to J. C. Hostetter and G. A. Bole, who so ably presided over the Symposia.

COMMITTEE REPORTS:

Standardization Committee, M. C. Booze, chairman.

A definition of magnesia brick has been written by Mr. Rochow and is being revised in view of criticism of some of the members.

Membership Committee, W. G. Owen, chairman.

Letters were written and bibliographies were distributed to prospective members and approximately twenty new members were secured through the activity of the committee. Prospect lists were made up of those who had belonged to SOCIETY and had resigned, those who attended the Meeting who were not members, and those who inquired for reprints or references from the SOCIETY publications.

Committee on Data, L. J. Trostel, chairman.

Respectfully submitted,

ROBERT F. FERGUSON,
Secretary.

LOCAL SECTION MEETINGS

St. Louis Section Meetings

On March 4, the members of the St. Louis Section met with the St. Louis Section of the American Society of Mechanical Engineers in joint dinner and business session. The subject for the evening was "Combustion and Smoke Prevention," presented by John Hunter, Consulting Engineer, and E. L. Ohle, of the Mechanical Engineering Department, Washington University.

The St. Louis Section entertained with a dinner dance at the St. Louis City Club on March 21. This was the first social gathering of the season and was greatly enjoyed and well attended by the St. Louis ceramists and their friends.

NOTES AND NEWS

OHIO STATE UNIVERSITY CERAMIC MEN HONOR PROFESSOR EDWARD ORTON, JR.

Appreciation has been expressed generally in ceramic circles for the vision, the organizing ability and the personal magnetism of Edward Orton, Jr., which made possible the establishment of the world's first collegiate department of ceramic engineering. There is no need in this note to again recite the resulting benefits which the ceramic industries have enjoyed and will continue to enjoy in increasing measure as technical ceramic research and education continue to grow in effectiveness and use. There had to be a beginning. Prof. Orton developed the mother crystal that has grown even beyond his hopes and anticipation but this growth has been vigorous because of Prof. Orton's very well prepared medium of thought development. He may have done a better job than he thought, but he did it and his doing of it is appreciated.

It is just fine that he is receiving these many expressions of appreciation while he is still vigorous in body and mind. He can the better enjoy the satisfying plaudits which are due him. The former students of Ohio State University, on the 30th Anniversary of the beginning of collegiate ceramics, desired to make a permanent record of their appreciation, a record that would in a live, vigorous fashion carry on after both Prof. Orton and those who knew him had passed beyond these earthly haunts. This testimonial of their appreciation they decided should have something of his character. They wanted their testimonial to continue serving even as the collegiate ceramic school idea which he inaugurated will continue to serve in increasing effectiveness. This they have accomplished by establishing a fellowship at the University where Professor Orton for so many years labored.

Professor Orton could have financed a fellowship in his own name. He has already built a beautiful monument to his father in the form of one of the most elegantly appointed, equipped and supplied geological libraries in America. It is exquisite in its furnishings and most complete in books relating to geology. This he has done in memory of his father, the first President of Ohio State University and one of America's foremost geologists. But to have done a similar thing for the perpetuity of his own name and in remembrance of his own works would not be to him thinkable.

Prized by him more than any of the many honors, next to the Distinguished Service War Medal, is this fellowship fund of $5000.00. In the hands of the University authorities this fund will grow until it will yield annually $600.00. This sum will be given as a prize to the ceramic student who has shown the best ability to carry on the scientific research which thirty years ago Professor Orton started. Thus will Professor

Orton's work carry on for all the years to come in his name and as a continued expression of appreciation of his pupils. It is this live expression of appreciation which Professor Orton prizes so highly. It was fitting that the Ohio State boys should have done this.

CHINESE ALUMNI MAKE UNIQUE GIFT TO OHIO STATE UNIVERSITY

An invitation was sent to each alumnus and ex-student of the Department of Ceramic Engineering of Ohio State University to return and participate in the cele-

bration ceremonies which were held on the University campus, February 16th last. A large number of the alumni and ex-students returned on this occasion and many of those who were absent sent expressions of regret.

One group of loyal ceramic engineers who were unable to attend this ceremony, made this the occasion for a beautiful gift to the Ceramic Department which gave them their education enabling them to return to their native land in which ceramics is supposed to have had its birth and to aid in the development of the art and science there. The gift is shown in the accompanying picture and the letter attached evidences the beautiful spirit which accompanies the gift.

上海四川路九十六號
中國製瓷股份有限公司

FACTORY:
149 WARREN ROAD
TELEPHONE W. 4060

THE NATIONAL POTTERY CO. LTD.
96 SZECHUEN ROAD
TELEPHONE C. 5374

CABLE ADDRESS
"POTTERY" SHANGHAI
BENTLEY'S CODE

SHANGHAI, CHINA

January 30, 1925.

Professor Arthur S. Watts,
Department of Ceramic Engineering,
Ohio State University,
Columbus, Ohio, U. S. A.

MY DEAR PROFESSOR WATTS:

Under separate box I have sent you a portrait of Dr. Edward Orton, Jr., painted on porcelain and framed in black wood. It is a present to the Department of Ceramic Engineering from its former students, Mr. Y. Y. Wong (graduate, 1920), Mr. S. Y. Liu (ex-student), and myself (graduate, 1919), in honor of Dr. Orton, its founder, on the occasion of its Thirtieth Anniversary Celebration.

Although we did not have the pleasure of having direct contact with Dr. Orton, we want to acknowledge our great indebtedness to him for the most valuable training gotten from the Department which he conceived and founded. We, students from China, join with the ceramists of other nationalities in the recognition of his eminent services to the ceramic craft of the entire world. We sincerely regret that distance prevents us from attending the Celebration in person.

You may be interested to know that the portrait was executed by a Chinese artist, known as "Deaf Cheng." The porcelain plate was made at King-teh-cheng, Kiangse, and the frame and stand are of typically Chinese design.

We shall be very glad to hear from you about the Celebration and the progress of the Department.

With warm personal regards to you and other members of the faculty, I remain

Yours respectfully,

CHI CHUN LIN

Address: 242 Avenue Haig, Shanghai, China.

BUREAU OF STANDARDS NOTES

Cast Iron for Enameling Purposes

Enamels for bath tubs, stove parts, and other cast iron wares often blister during the firing process, causing loss to the manufacturer and increased cost of the perfect product to the consumer.

The Bureau of Standards, in coöperation with the American Ceramic Society, has undertaken a thorough study of cast iron for enameling purposes with a view to determining the iron most suitable for this work, and, if possible, the cause of blistering of the enamel when fused onto castings made from certain types of pig iron. Two types of pig iron are being used in the cupola charge. It is a popular opinion among enamelers that castings made from 100% pig iron of these two types cause blistering of the enamel, while this condition is remedied somewhat by adding scrap castings to the melt. In each of the first two experimental runs of castings, 100% of the above mentioned pig iron was employed.

Sample castings were enameled both in the laboratory and in the plants of various manufacturers. The enamels used are designated by the trade as the wet and dry process enamels. The wet process enamel is ground fine and suspended in water as a slip, using clay as the floating agent. This slip is sprayed onto the casting, dried and fused at comparatively high temperatures. The dry process enamel is also fused at these temperatures, but the casting is first heated and the dry enamel powder sifted on to give a smooth coat.

The results of the enameling of the first runs of castings have been checked. It was found that blistering occurred in the enamel on all castings except those on which the single coat wet process enamel was fused at comparatively low temperatures. The blisters appeared as pinholes in the enamel and as dimples on the surface where the enamel was too thick or viscous to allow the bubbles to "blow" through. The highest temperature at which no blistering occurred was 1290°F. Above this temperature unsatisfactory results were obtained. No conclusions have been drawn, since the investigation is not far enough advanced. Further work has been planned to include varying cupola charges from which castings are to be enameled, both in the laboratory and in commercial plants. Chemical, metallographic, and spectroscopic analyses will be made of the castings before and after enameling in order to determine any changes which might take place, due to the enameling process. This report covers the results obtained with 75 castings. It is estimated that a similar number will be used from each cupola run.

Standardization of Seger Cones

The work started by the Bureau some months ago in connection with the standardization of Seger cones is making satisfactory progress.

A preliminary report on this subject was presented before the American Ceramic Society at the Columbus meeting on February 18th. The number of papers on the program prevented formal discussion of the report, but informal conversations with representative members of the Society assured the Bureau of the interest being taken in the work, and the general approval of the methods being followed.

Plastic Refractories

Clay refractories, furnished to the trade in their plastic form, are rapidly supplanting special shapes in boiler settings and similar installations. The demand for this material for repair work is also rapidly increasing, so that at the present time it has been estimated that the total daily output exceeds 100 tons. Because of the increasing importance of this commodity to the trade, and the fact that the Government is contemplating the formation of specifications for its purchase, the Bureau of Standards undertook to determine the physical and chemical characteristics of several commercial brands of these plastic refractories.

Test specimens, made by hand-ramming in molds, were fired, subjected to standard and modified tests for fire clay refractories, and also analyzed chemically and petrographically. The information obtained indicates that plastic refractories as now furnished to the trade are inherently the equivalent of the highest grade fire clay brick.

A comparison of softening point determinations and chemical analyses by three independent laboratories shows that a variation of from one-half to one cone in softening point determinations, and more than 5% on some constituents in chemical analysis, can be expected for different samples representing one brand or product.

BUREAU OF MINES NOTES

Graduate Fellowships Offered

Graduate fellowships in mining, metallurgical and chemical research are offered by prominent institutions of learning in various states, in coöperation with the Bureau of Mines of the Department of the Interior. The object in offering these fellowships is to assist in the solution of different problems being studied by the Bureau of Mines that are of particular importance to the region in which these institutions are located. The fellowships offer excellent opportunities for qualified young men to become proficient in the fields of mining, metallurgical and chemical technology, and to prepare themselves for highly specialized work in these fields.

The following-named institutions offer such fellowships for the college year, 1925–1926:

University of Alabama, Tuscaloosa, Ala., 5 Fellowships, $540 each.
University of Arizona, Tucson, Ariz., 2 Fellowships, $660 each.
Carnegie Institute of Technology, Pittsburgh, Pa., 4 Fellowships $750 each.
University of Missouri, Rolla, Mo., 4 Fellowships $800 each.
Ohio State University, Columbus, Ohio, 3 Fellowships, $750 each.
University of Utah, Salt Lake City, Utah, 5 Fellowships, $750 each.
University of Washington, Seattle, Wash., 5 Fellowships, $750 each.
University of Idaho, Moscow, Idaho, $750 each.

Detailed information in regard to the terms of these various fellowships may be obtained from the Department of the Interior, Bureau of Mines, Washington, D. C., or from the different institutions named.

SOCIETY OF GLASS TECHNOLOGY MEETING

A meeting of the Society of Glass Technology was held in the Applied Science Department, the University, St. George's Square, Sheffield, Wednesday, Feb. 18, the President, S. C. Halse, in the chair.

The meeting was devoted to a consideration of the use of sillimanite in the glass industry, two papers being presented. Within the last two years, very large deposits of sillimanite have been discovered in India and these deposits are now being worked by a British firm, Pawle and Brelick of London, and all the experiments described were conducted with material from this source.

The first paper was entitled "A Study of Sillimanite for the Purpose of Preparation of Refractory Materials," by A. Cousen and W. E. S. Turner.

The authors observed that recent developments in the glass industry had emphasized the need for good refractory materials, and although much has been done to

improve and render more uniform the fire clays now employed, it was of importance to examine other material likely to give better results. The authors had made a study of sillimanite, and the effect of variation of grain size and of the use of varying types and proportions of bonding agent were dealt with. The most plastic mixtures, and those giving on fire clay the most stable and resistant pots were obtained by using sillimanite wholly or largely in the fine condition in which the bulk of the material passed through a 100-mesh sieve. With ball clay as a bonding material good results were found when a proportion of 15 to 30% of bond was employed. The porosity of hand molded specimens was inversely proportional to the amount of bonding agent used and with the addition of 30% of ball clay reached as low as 22%. Actual melting tests with soda-lime, potash, lead and fluoride opal batches gave glasses superior in color to, and having a lower iron oxide content than those melted in good fire clay pots. Test slabs both with 15 and 30% of bond withstood a larger breaking load than fire clay slabs after firing at 1000 to 1400°, but after heating to 100° or 800° the clay slabs gave superior results. Stourbridge clay gave a less plastic mixture which gave on firing to 1400° a more porous texture than equivalent mixtures in which ball clay was used. The Stourbridge clay mixtures, however, gave promise of producing quite good results when molded into shape under pressure. Bentonite, a hydrated silicate of aluminium of variable composition, although giving the most plastic mixtures proved unsatisfactory in practice, and the results obtained did not justify its employment as a bonding agent.

The second paper was entitled "Some Notes on the Use of Sillimanite as a Glass Works Refractory," by F. G. Clark and W. J. Rees. The authors explained that for many years manufacturers have been looking for a refractory material which would not only stand the higher temperatures at which in recent years furnaces had been worked, but also withstand the action of melting batch and molten glass upon it at that high temperature. Tests under commercial conditions showed that molten glass had very little attack on articles made of sillimanite and should have very little effect on sieges made of this material. Brick of various sizes and thicknesses had also been made of a sillimanite mixture and used for filling up the exit flues of furnaces when they had worn too big. It was found that these brick stood the heat perfectly. The mixture was also used in a damp state for repairing the bad places between the pillars and springers in an old furnace, with excellent results. The best results had been obtained with sillimanite bonded with from 10 to 25% of ball clay. A covered pot had been made from 25% ball clay mixture soaked for 4 weeks before use. This pot was 43 inches high and took 13 days to make. Its cost was greater than that of the ordinary fire clay pot, but longer life in the furnace and freedom from pot stones would compensate for this. The material was also recommended for rings floating in the glass and for bottoms of tank furnaces. Its thermal conductivity was higher than that of fire clay. The authors expressed the opinion that sillimanite was the best refractory material yet known for use in the hottest part of any glass furnace, either in contact, or out of contact, with glass.

Two other papers were communicated but not read, namely.

(*a*) "The Early Glasshouses of Bristol," by Francis Buckley.

(*b*) "Sur la Viscosite et l'Allotropie du Verre," by Prof. Henry Le Chatelier.

NEWS FROM THE UNIVERSITY OF ILLINOIS

Mr. Douglas F. Stevens of the Acme Brick Company, Danville, Illinois, addressed the students in Ceramic Engineering, University of Illinois, Friday, March 13, on

the operation of the new system of firing which has recently been installed in their plant.

The Illinois Gas Association has recently presented to the University of Illinois several gas furnaces of different types. The Department of Ceramic Engineering received as its share of the gift, a volcano surface combustion fusion furnace, a testing furnace requiring the use of gas under pressure and capable of reaching temperatures of 3200 to 3300° F. Also, a special surface combustion furnace for firing ceramic wares under high temperature conditions.

Mr. A. V. Bleininger of the Homer-Laughlin China Company, Newell, W. Va., delivered three lectures to the students of the Department of Ceramic Engineering, University of Illinois, on March 18 and 19. The topics of his addresses were: (1) The work of ceramist; (2) The operation of tunnel kilns; (3) Research in factory practice.

CALENDAR OF CONVENTIONS

Organization	Date	Place
Am. Assn. of Flint and Lime Glass Mfrs.		
(Annual Meeting)	July, 1925	Atlantic City, N. J.
AMERICAN CERAMIC SOCIETY		
(Annual Meeting)	Feb. 8–13, 1926	Atlanta, Ga.
(Summer Meeting)	July, 1925	Toronto, Canada
(Fall Meeting)	Oct. 1, 1925	New York City
Am. Electrochemical Soc.		
(Spring Meeting)	April 23–25, 1925	Niagara Falls, N. Y.
(Fall Meeting)	Sept. 24–26, 1925	Chattanooga, Tenn.
Am. Engineering Council	Jan., 1926	
Am. Foundrymen's Assn.	Oct. 5–9, 1925	Syracuse, N. Y.
Am. Gas Assn.	Oct. 12–16, 1925	Atlantic City, N. J.
Am. Inst. of Chem. Engrs.	June 22–25, 1925	Providence, R. I.
	July 13–16, 1925	Leeds, England
Am. Inst. of Min. and Met. Engrs.	Aug. 31–Sept. 5	Salt Lake City, Utah
Am. Iron and Steel Inst.	May 22, 1925	New York, N. Y.
Am. Mining Congress	May 25–29, 1925	Cincinnati, O.
Am. Soc. of Mechanical Engrs.		
(Spring Meeting)	May 18–21, 1925	Milwaukee, Wis.
(Annual Meeting)	Nov. 30–Dec. 3	New York City
(Pacific Coast Regional Meeting)	June 22–25, 1925	Portland, Ore.
Am. Soc. for Testing Materials	June 22–26, 1925	Atlantic City, N. J.
Assn. of Scientific Apparatus Makers	April 23–25, 1925	Washington, D. C.
Baltimore-Washington Section		
(AMERICAN CERAMIC SOCIETY)	April 4, 1925	Washington, D. C.
Brussels International and Commercial Fair	March 25–April 8	Brussels, Belgium
Chemical Equipment Exposition	June 22–27, 1925	Providence, R. I.
Common Brick Manufacturers Assn.	Feb., 1926.	
Eastern Clay Products Assn.	April 14, 1925	Pittsburgh, Pa.
Glass Container Assn.	April 30–May 2	Atlantic City, N. J.
Institution of Chemical Engineers	July 13–16, 1925	Leeds, England
Manufacturing Chemists' Assn.	June, 1925	New York City

Mining and Met. Society of America	Jan. 12, 1925	New York City
Natl. Academy of Sciences	April 27–29, 1925	Washington, D. C.
Natl. Assn. of Mfrs.	Oct. 26–28, 1925	St. Louis, Mo.
Natl. Assn. of Stove Mfrs.	May 13–14, 1925	New York City
Natl. Chemical Equipment Assn.	June 22–27, 1925	Providence, R. I.
Natl. Clay Products Industries Assn.	April, 1925	Chicago, Ill.
Natl. Lime Assn.	May 26–29, 1925	Briarcliff Manor, N. Y.
Natl. Exposition of Chem. Industries	Sept. 28–Oct. 3, 1925	New York City
Soc. of Chem. Industry	July 13–16, 1925	Leeds, England

BULLETIN

of the

American Ceramic Society

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

Vol. 4 **May, 1925** **No. 5**

EDITORIALS

CERAMIC RESEARCH INSTITUTES

Two research institutes have been launched. The Clay Products Institute and the American Refractories Institute have organized and started coöperative research work. They represent collective efforts of plant owners to secure from research and education what individuals working alone can obtain only at large money and time expenditure. Coöperation and coördination are requisite to completeness, thoroughness and speed in developing information essential to keeping apace with the ever-pressing economic and quality demands. This has been the motive of those who have labored through the American Ceramic Society. This Society would be unfaithful if it did not give every encouragement to whatever organization scheme the ceramic manufacturers may wish to set up to obtain the most efficient coöperation. This Society lauds the principles and the purposes which actuated the men who are responsible for the formation of these two Research Institutes.

For several years this Society has urged coöperation by the financial interests in ceramics. These Institutes are justly viewed as resultants of the constant efforts which have been made to interest plant owners in research and education. This Society enjoys considerable satisfaction in the steadily growing support of coöperative research by the trade press and by the trade associations.

The remaining tasks for the AMERICAN CERAMIC SOCIETY are (1) to urge all groups of ceramic manufacturers to organize similar institutes or to show how they may join those already under way; (2) to assist in finding a flexible and economical means of coördinating the "over head" or general research activities in which all groups of ceramic manufacturers are mutually interested; (3) to continue an organization in which all ceramic technologists and scientists may have a clearing for and a means of recording results of research.

The AMERICAN CERAMIC SOCIETY belongs to ceramic people as generally as a republic does to its citizens. It is for and by all ceramic groups. Its scheme of decentralization of control and activities through the seven Industrial Divisions is not greatly unlike the decentralization in government by states. The steady growth in strength and in effectiveness of this *seven societies in one* and the continued harmony of the *seven simultaneous meetings* bespeaks unity in ideals and purposes of ceramic technologists generally, irrespective of the wares they produce. The SOCIETY truly is by, and for, all ceramists with special benefits to none not enjoyed by all.

This SOCIETY has operated for twenty-seven years in the manner dictated by its members. It has served important purposes which purposes have gradually increased in importance. So successfully has the SOCIETY promoted activities for the advancement of ceramic science, technology and art that not only has the SOCIETY grown in membership but ceramic schools have multiplied, the ceramic trade journals have increased in numbers and plant owners generally have come to a realization of the financial benefits of ceramic research and education. The character of subject matter in the trade press has changed from trade altogether until now a fairly large amount of space is devoted to presentation of strictly technical and scientific information and data.

The AMERICAN CERAMIC SOCIETY has done nothing and merits nothing not creditable to its individual members. The credit for the scientific and technical advancements in ceramics and the increased appreciation generally of the benefits of research and education belong to the individuals and to the manufacturing concerns. The SOCIETY itself is inanimate, it merely reflects the desire there has been for coördination of individual efforts to gain the largest possible ceramic knowledge at the least cost in time, effort and money. It has changed its procedures and activities from time to time to meet the changes in conditions and requirements resulting from the continually increasing employment of ceramic science. There is nothing more certain than that this SOCIETY will adjust itself to meet the new situation caused by the organization of research institutes by the plant owners because all that the SOCIETY now is and all that in the future it will be is in response to the needs of its individual members.

If in the extreme, this SOCIETY should be found impotent it will automatically cease to exist and that too with no regrets resident in the minds and hearts of anyone, not even of those who have labored most faithfully and continuously for the SOCIETY. It has been ideals and purposes for which supporters of the SOCIETY have worked rather than for a certain form of organization. If the several research institutes can find a means for joint collaboration in researches and a means of collecting and making information available they will then be serving the purposes for which this SOCIETY was organized and has been continued.

It is to this end that we have urged participation in and control of the affairs of the SOCIETY by plant owners. It has always been very evident that the several activities in which the SOCIETY through its committees has engaged would have been much more effectively executed had the plant owners been more intimately interested and in control. The fact that the SOCIETY has grown in membership, strength and in effectiveness shows that its purposes, methods and organization are not far wrong.

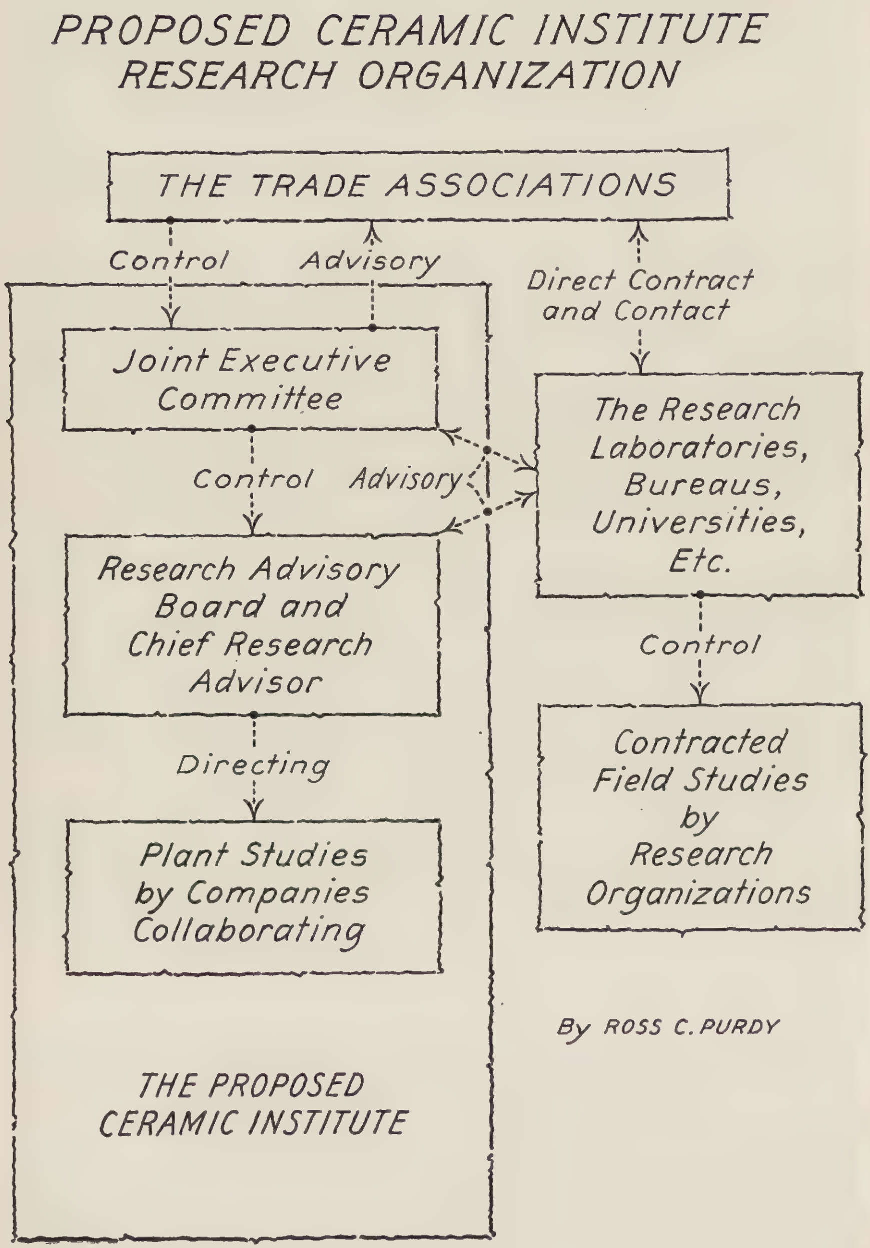
There is no expectation of this SOCIETY becoming impotent. It will not serve its most useful purpose until the plant owners through their respective trade associations or research institutes find ways and means of coördinating through the SOCIETY. This, of course, will be possible only when a means is worked out for direct control of the affairs of the SOCIETY by the industrial research groups or institutes.

The smooth and effective working together for years of the self-governed Industrial Divisions of the SOCIETY shows the possibilities and points to the benefits which would accrue to all if these Divisions should be replaced by industrial research institutes.

It is to this end that the Secretary has made a recommendation of a scheme of collaboration. The presentation of the scheme proposed is only another suggestion to be considered with those which have been and will continue to be made, all for the purpose of finding the best ways and means of collaboration of ceramists generally and collectively.

A SUGGESTED SCHEME OF COLLABORATION BY CERAMIC INSTITUTES AND TRADE ASSOCIATIONS

The scheme here suggested is a national ceramic research council participated in and controlled by all ceramic industrial groups. It is not an arbitrary self-governed organization. It would operate in the manner and to the extent determined by ceramic plant owners. It is proposed that this council shall not conduct investigations but shall serve simply as a clearing-house for information and in an advisory capacity to the ceramic manufacturers' organizations and to the laboratories. It would


PROPOSED CERAMIC INSTITUTE
RESEARCH ORGANIZATION
THE TRADE ASSOCIATIONS
Control
Advisory
Direct Contract and Contact
Joint Executive Committee
Control
Advisory
The Research Laboratories, Bureaus, Universities, Etc.
Research Advisory Board and Chief Research Advisor
Control
Directing
Contracted Field Studies by Research Organizations
Plant Studies by Companies Collaborating
By ROSS C. PURDY
THE PROPOSED CERAMIC INSTITUTE

not be in charge of research nor have the right to contract for research. Its purpose would be to collect information and to advise on research problems and facilities.

Scientists observe, theorize and make record of the knowledge they originate. The latent values of scientific facts are translated into industrial aids only when plant technologists with a vision have the opportunity to assemble and apply them. Neither the laboratory worker nor the plant technologist alone can work out these things; they must collaborate closely. No research council can be effective that does not assure close collaboration of the plant technologist and the laboratory scientist. And the most searching and effective collaboration is had when all ceramists irrespective of the kind of ceramic ware produced and all the research laboratories have a common means for pooling their information.

The research institutions (bureaus and universities) are primarily laboratories and their investigations are limited to those which can be prosecuted in the laboratories. They can extend their observations to plant operations only in cursory fashion. Their research personnel cannot wholly acquire the knowledge, point of view and vision of the technical man whose daily work is factory routine and whose responsibilities primarily are product and production. Neither the laboratory nor the plant technologist has that complete information, vision, thought habit and interest which is necessary to the best selection, analysis and prosecution of an investigation of a plant problem. The laboratory scientist and the plant technologist so supplement one another that when joined in prosecution of a research they complete the requisite human ability to conduct researches most effectively. It is time industrial technologists be provided with a financed means of collaboration with men in the research laboratories and with their fellows in other lines of ceramic manufacturing. This provision is made in the scheme here presented. The Research Advisory Board would be composed of technical men from the plants, meeting frequently and doing assigned work at home.

A great deal of information most valuable to a given ceramic industry was originated by manufacturers of apparently wholly different types of ceramic ware. There is much which is basic in the fabrication of all ceramic wares, differing only in methods and means of applications. This is as truly the fact in the production of two quite widely different ceramic wares as it is true in the production of different varieties of the same class or type of ware. The manufacturer would gain effectiveness, breadth of vision and actual knowledge of facts in proportion to the varieties of experience and concepts of their research council. This council should be comprised of technologists from a wide variety of ceramic enterprises and should be in close relations with all of the research laboratories.

The organization chart here presented provides an effective means of

collaboration by plant executives, plant technologists and laboratory investigators. It provides for as little or as much collaboration of trade associations and research institutes as the research problem in hand would warrant. It provides for direct relation by each trade group separately or jointly with the research laboratories. The Research Advisory Board would not be a "go between" nor would it conduct laboratory investigations. Its work would consist of assembling facts and advising on research problems.

In this scheme, there is the maximum of flexibility, simplicity, economy and effectiveness. There is avoidance of duplication. It provides for complete supplementing of experiences, training and viewpoints of the business man, plant technologist and laboratory scientist of all ceramic trade groups. It gives the business owner that same exhaustive study and council on research problems and research facilities as they have in legal matters through their legal councillors. It furnishes the means of determining the abilities of universities to conduct researches. It provides council to both the manufacturer and the laboratory scientist in the conducting of ceramic investigations. The universities and bureaus are in need of this sort of industrial contact as are the manufacturers.

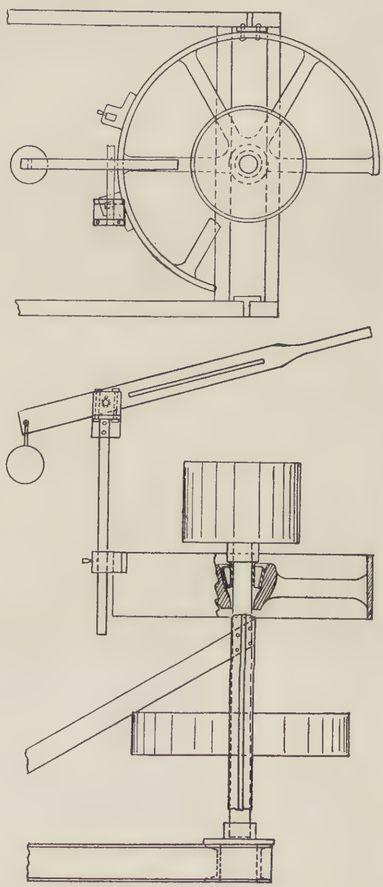
PAPERS AND DISCUSSIONS

A HOME MADE JOLLEY

By Wayne E. Barrett

Recently it was necessary to have a jolley for making some jiggered pieces from the clay used in the manufacture of a regular line of products. Since the task did not warrant the purchase of a machine, one was built.

The head was made by shrinking a six-inch iron band on a trued drier-car wheel from which the flange had been removed. This was then keyed to a shaft and trued up in a lathe.



A drive-wheel from an Elwell-Parker electric truck was used to support the shaft. The Timken taper bearing carried the weight of the head, shaft and drive pulley. This gave a smooth running wheel, entirely free from vibration. The lower end of the shaft was held in position by a babbitted foot bearing.

Two small T-irons carried the electric truck wheel while two pieces of drier-car slats were used to give a lateral bracing. This was all carried on a base consisting of two 4-inch channel irons 5 feet long and three 4-inch channels 18 inches long all fastened together by pieces of angle iron.

To support the pull-down, two worn-out brakes from a locomotive were bolted to the truck wheel. Each of these had a $^5/_8$ by $1^1/_2$-inch hole for the brake arm and this hole was taken advantage of by loosely fitting two uprights of $^5/_8$ by $1^1/_2$-inch strap iron by a set screw. This made possible a variable height for the tool or profile which shapes the pieces.

The top ends of these pieces of bar iron were slightly twisted to make them parallel and a small piece of cast iron carrying a small ball bearing was attached to each of them. These ball bearings carried a shaft to which was keyed the pull-down arm, made of $^3/_4$ x 3-inch bar iron. The

pull-down arm had been previously slotted by a portable lathe key-seating machine to allow for adjustments of the profile.

The wheel was driven by a quarter-twist belt over a motor pulley, and the motor controlled by means of a foot switch.

ADEL CLAY PRODUCTS CO.
ADEL, IOWA

A TEST FOR DETERMINING THE WELDING PROPERTIES OF GLASSES[1]

BY ROBERT J. MONTGOMERY

The method of determining the welding properties of glass as described by Mr. Sharp has been used for some time in our plant with considerable success but we have found that under certain conditions, the results obtained are of very little value unless certain factors are taken into account.

This test is to work the two glasses to be welded into rod form. The ends of these two rods are held together and heated to softness so that the ends are welded together. The junction is pulled out into a thread 10–15 inches long with a pair of forceps. The heavy end at the forceps is broken off and the curvature of the thread will indicate which glass has the greater expansion. The glass with the greater expansion will be on the inside of the curve.

We found in welding a soda-lime glass to a lead glass that if there was no curvature, indicating no strain, glasses would usually not weld satisfactorily. To give a satisfactory weld, a deflection of the thread of about 2 inches in 10 inches was necessary. This deflection was on the soda-lime side of the thread indicating that the soda-lime glass contracted more than the lead glass.

When a soda-lime glass was welded to a barium glass, the reverse was true. To give a satisfactory weld, a deflection of the thread of about 1.5 inches in 10 inches was necessary but this deflection was on the barium side of the thread, indicating that the barium glass contracted more than the soda-lime glass.

A consideration of the subject brought out that there were two different kinds of strain introduced into a drawn thread of this kind. First, of course, is the strain due to any difference in contraction due to the composition of the glass and second is the strain introduced by sudden chilling of the thread in air. The test piece is not annealed.

Annealing the test threads gave us the desired information. The lead-soda-lime combination straightened out and gave no curvature and the barium-soda-lime thread did the same. Apparently when the annealing

[1] A discussion of the paper by Donald E. Sharp, *Jour. Amer. Ceram. Soc.*, **4** [3], 219 (1921).

temperature of both glasses is the same or the composition of the two glasses is about the same, the strain introduced by no annealing is about the same in both. The strains then, being equal and opposite, caused no deflection. If the glasses are dissimilar in annealing temperature and composition, the thread will curve toward the one having the higher annealing temperature.

In annealing the threads, trouble was encountered unless they were held vertical so the thread would be affected only by the difference in expansion and not be bent at the annealing temperature by gravity. We have set the threads in plastic clay like an inverted Seger cone, and suspended this on a small iron stand which could be put into the leer. In some cases there is a tendency for the ends of the threads to curl up in the direction of the harder glass. In a lead-soda-lime fusion, the soda-lime glass would be on the inside of the curl. Evidently the annealing temperature was too high and the glass became quite soft.

Bausch and Lomb Optical Company
Rochester, N. Y.

MEDIEVAL EUROPEAN POTTERY[1]

By Robert F. Sherwood[2]

ABSTRACT

This paper deals with pottery and porcelain from the time of the Fall of Rome through the sixteenth century. Italian pottery before the Renaissance and Majolica ware are discussed under Italian pottery. French pottery is classed under the two heads of Faience and Palissy ware. The influence of the Moors and Arabs upon Spanish pottery and also the origin of Majolica ware is taken up under Spanish pottery. The pottery of England before the Norman period and after the Norman Conquest is discussed. The pottery of Central Europe is dealt with under the head of German pottery. Porcelain is discussed from 200 B.C. on through its introduction into Europe and up to the earliest imitations of porcelain in the sixteenth century.

The word "pottery" in its widest sense includes all objects fashioned from clay and then hardened by fire, though there is a growing tendency to restrict the word to the commoner articles of this great class and to apply the word "porcelain" to all finer articles. Chas. F. Binns makes the distinction between the "commoner articles of this great class" and porcelain; porcelain has a low biscuit fire and a high glaze fire, while the commoner articles have a high biscuit fire and a low glaze fire. For this reason porcelain will be discussed under a separate portion of this paper.

Time or space does not permit a discussion here of Greek and Roman pottery. Suffice it to say that the pottery of the Greeks reached a quality

[1] Presented at the Annual Meeting, American Ceramic Society, Columbus, Ohio., Feb., 1925. (Art Division.)

[2] Ceramic Engineer, Pass & Seymour, Inc.

that has never since been equaled. And to the Roman potters the world is indebted for much of its advancement in clay-work.

Italian Pottery

After the fall of the Roman Empire but little trace remained of the arts practiced in the times of her prosperity. Such knowledge as that possessed by the potter cannot absolutely pass away, but so much of this knowledge is special and detailed that it is not a matter of wonder that both the Greek and Roman art disappeared.

Little is known of the potter's art in Italy after the fall of Rome till the 13th century. The traditions of the Roman potters appear to have been gradually lost, leaving behind only sufficient skill to make crude crocks for domestic use and to coat them, if required, with a crude yellowish lead glaze sometimes stained to a vivid green with copper oxide. Applied ornament of roughly modeled clay and scratched with designs were the chief decoration of such wares which were of the same class as the medieval pottery of England and the north of Europe. In the 12th and 13th centuries, however, contact with Asia Minor, Syria, Egypt and Spain, where ceramic skill had been highly developed in fresh directions, introduced into Italy as well as the rest of Europe, those superior wares characterized by a white surface decorated with bright colors under a brilliant transparent glaze, and beautified by metallic lusters. The Italian potters did not remain long unaffected by these influences.

But first let us glance at the native wares of Italy. These wares were made of coarse and often dark-red clay, coated with a white clay slip (a kind of pipe-clay) and covered with a crude lead glaze, either yellow or green. Later, while the vessel with its white clay coating was firm, yet soft enough, patterns were scratched or engraved through the white slip to the red body beneath. In the latter half of the 15th century a sudden advance took place in the coloring of this ware. Instead of simple glazes of uniform color, underglaze colors, green, purple, blue, brown and black, were applied in bold splashes under the straw colored glaze. This produced a rich and decorative effect by very simple means.

Majolica Ware

The name majolica ware indicates that the origin of the ware by this name was the island of Majorca, located in the Mediterranean off the east coast of Spain. More recently the view taken is that the knowledge of the manufacture was brought into Spain by the Moors who also settled in the Balearic Isles, and there practiced the potter's art. It has now been shown that a number of these pieces found in Italy are of Spanish origin.

The piece is covered with an enamel, the design then sketched and the

luster added. This consisted of a paste of clay containing the required oxide. The pieces were then given a low fire, a dull red heat. At this heat fuel producing smoke was added. When the pieces were cooled they were scrubbed, and underneath was the luster. This was due to the thinness of the film between the enamel and the paste containing the oxide. All the artists attempted this process, and thus the industry grew. The risks of the luster process were great, so that its use was relegated only to inferior wares, and then the process was relinquished and forgotten until its rediscovery in the latter 19th century. When one of the later majolica painters had spent weeks on the decoration of some vase or dish, it is not likely that he would care to expose it to any risks that could be avoided. Only the most experienced along the line of luster making were successful to any degree.

The Gubbio luster, as it is called, is best known to us through the works of Maestro Giorgio, whose distinctive luster is a magnificent ruby-red, unlike any other. In all probability the luster process was quickly abandoned on the fine painted majolica, because the increasing efforts to make a picture were discounted by so uncertain a process.

French Pottery

The pottery of medieval France was, for the most part, similar to that made generally in Europe. They were rudely shaped vessels of ordinary clay often ornamented and glazed with a yellow or brown lead glaze, or if coated with white slip, decorated with bright green glazes, and toward the end of the 15th century with grayish blue. The later specimens of this ware were extremely decorative.

Faience

French faience should be distinguished from dishes on the one hand and porcelain on the other. It is a low-fired, fancy pottery. When the French potters wanted to get some outside potters, they went to Faenza in Italy for men. Hence the ware that these men and their successors made was called "faience." The body of this ware is a creamy white, and the decoration is effected by inlaying fine lines and panels of darker colored clays, the whole being covered with a clear, soft glaze. The pieces show three periods of production: the crude period, the fine period in which the potter was successful, and the last stage when the pieces are overloaded with ornamentation.

During the 15th century came the distinctly French pottery—the Henri Duex ware, and the pottery of Bernard Palissy and his imitators. The Henri Duex or Oiron ware was believed to have been made by a librarian and his assistant for their patroness. Some years ago this theory was

disputed and the originator of the ware was said to be a potter of St. Porchaire. But all we know is that the ware dates back from the reign of Henry II, and that it was probably made somewhere near Oiron. The ware also shows marks that indicate that the maker knew something of bookbinding. The date of the production is believed to have been about 1524. This ware belongs to the faience class.

Palissy

"Bernard Palissy was a genius of original talent, and has gained a legendary rank as one of the great potters of the world, which his pottery does not warrant." He seems to have been trained as a glass painter. He was shown a cup which he took to be covered with white enamel—probably Chinese porcelain. He is supposed to have spent sixteen years in search for the white enamel. But when he settled down to make "Palissy Ware" he did nothing more than to carry out the perfection of the methods of the village pot makers of his own district. On a hard-fired red clay he made groups of molded plants, shells, fishes and reptiles. These he painted with crude green, brown and yellow colors, and glazed the whole with a well prepared lead glaze. This lead glaze was transparent, perhaps slightly yellow. An example of one of his pieces represents the bottom of a brook as he saw it. His colored glazes were beautifully rich and pure, and his style soon had numerous imitators.

All his productions are not of this class, however. He made some fine pieces with figures modeled in relief, and also some beautiful perforated dishes. His religious opinions led to his imprisonment, from which he was released after a time. But he was later taken to the Bastile where he died in 1590.

The succession of tin-glazed ware was resumed in France when the Duke of Nevers invited to that place a number of skilled artisans from Italy. The only thing in common between the wares of Faenza and Nevers was the use of tin in the glaze. The peculiar tint of blue and the exquisite purity of the white constitute the excellence of the faience of Nevers. This blue and white were the leading characteristics of this particular center.

Spanish Pottery

When the Arabs and Moors invaded Spain in the 8th and 12th centuries, they left their mark on the pottery of that country. There, as elsewhere, pottery was then being produced from the natural substances at hand. The material was simply what was found in the earth, and the preparation of the material for its use in pottery was crude. But in spite of all this, the pottery produced during that time has a subtle beauty, and it is impossible to duplicate it. For example, we know the chemical ingredients

of Cornwall stone, a mineral found in England and used extensively there. But we cannot put these ingredients together and make Cornwall stone. In the same way this pottery cannot be duplicated.

Majolica Ware—Its Origin

The nature of the work was in accordance with the location. When the Moors came into Spain they found an abundance of tin and lead. Here they began to use the natural substances for their pottery as before. So they began to experiment with the materials at hand. And the result was a white enamel. And with this their technique also changed. At first this pottery was called stanniferous faience, but it finally was called majolica faience, the name coming from the island of Majorca, near Spain, where some of this ware was produced.

The knowledge of this majolica faience spread along the southern coast of Europe, and finally to Italy. The time that this knowledge reached Italy was during the 16th century, the period of the Artistic Renaissance. During this period the pieces show elaborate styles of decoration, and also an occasional two firings. Up to this time the majority of the ware made by the Moors was only one fire.

Of the Hispano-Arabic pottery there seems to be no accurate knowledge, but of the Hispano-Moresque numerous examples remain. The tin enamel is of great beauty, and an important feature is made of colored lusters. A notable specimen of this ware is the famous Alhambra vase. The colors of the decoration are a pure blue enamel with a gold luster on a white ground. This vase was accurately copied by Theodore Deck of Paris, and the copy may be found in the Museum at South Kensington. Exportation of ware of this type doubtless laid the foundation of the industry in Italy, and led to the "Italian Majolica," which everywhere became famous.

Pottery of England

Throughout the Middle Ages the pottery made in England was, broadly speaking, only such as would be used by the lower classes. A few pieces of somewhat exceptional merit have been met with, but they are probably the occasional show pieces made by the humble peasant potter as a propitiatory token for his feudal lord or monastic overlord. Apart from a small number of exceptional pieces such as these, the pottery of England remained down to the 17th century practically indistinguishable from the common wares made all over the continent.

The pieces were made of ordinary clays, firing to various shades of buff, drab, brown and red; the material was coarsely prepared and capable, therefore, of receiving but little finish. The shapes were of the simplest, and such as were common in many countries during the early stages of the

potter's art. The glaze, when it occurs at all, is the simple lead glaze obtained by dusting powdered lead ore over the clay vessel before firing. On many pieces the glaze was colored by the accidental or intentional addition of the simpler metallic oxides, oxides of manganese, iron and copper. It was from these modest beginnings that the English potters of the 17th century gradually advanced.

Pottery of the Norman Period

Of the pottery of the Norman period but little has been said, and that because little has been known. Pottery was, indeed, ill suited to the roving propensities and wandering life of the Normans; besides they could hardly have brought into England an art almost forgotten in their own country. Our scanty knowledge of this period is confined to coarse pots and fragments found in excavations.

From these we learn that the pottery of this period consisted largely of pitchers, dishes, bowls and porringers; the bowls and dishes being used for drinking purposes as well as for placing cooked meats in; the pitchers for holding and carrying ale, meal and water to the table; and the porringers both for eating and cooking. The body of this Norman pottery was usually a coarse clay, and the vessels bear evidence in many instances of the wheel being used. The wheel was simply a revolving piece of wood, or other material, upon which the piece could be placed and built up by hand or tools. In color these vessels are sometimes of a reddish brown, others red, while others are nearly black; and many of the pitchers are either wholly or partially covered with a green or other glaze. Many pieces are quite devoid of ornament, and some are rather highly decorated.

Later these fictile productions began to assume a more ambitious range. The floors of churches and convents were paved with tile, inlaid with clays of various colors, and whereupon Gothic ornaments and even subjects of figures were depicted. These tiles represent a great variety of processes, being coated with glazes of different colors, embossed and pressed, and inlaid or painted with white clay.

German Pottery

The pottery of Central Europe in the 16th century may be classed as salt glazed stoneware. Before this time the people were engaged too much in warfare to have much of anything to do with the potter's art. Some accounts give the discovery of salt glazing as late as the 17th century. Stoneware glazed by salt no doubt derives its name from the close relation borne by the ware to stone itself. Hard and impervious, granular in texture, no better comparison could have been made.

The potter's wheel was used for the form itself, and the fanciful embossment was applied by means of small pieces of soft clay which had been

pressed into molds of the required pattern. Hitherto every substance used for glazing had been applied to the ware either in the clay or biscuit state, by dipping the piece in a vessel of glaze, or by painting the mixture over the ware. In stoneware the glaze is vaporized in the oven and unites itself with the clay at the same time. The potters of Germany or Flanders probably discovered this. The glaze used was simply common salt, which was thrown into the oven when at its greatest heat. Being volatilized, the salt entered into combination with the silica in the clay, forming a thin glassy coating all over the piece.

The main centers of the production of German stoneware lay in the district now known as Rheinish Prussia. Early in the 16th century fine work was produced at Seigburg, near Bonn. The clay used was commonly of the creamy white variety.

Porcelain

Now let us turn to the story of porcelain. This story has its beginning in Celestial China. Two thousand years before the Christian Era, the Chinese were great potters, and in 200 B.C. they were making a high grade porcelain. The high antiquity and perfection of the art of making porcelain by the Chinese, many years before any specimens of it found their way into Europe, are well authenticated by the older records of the Celestial Empire, which were brought to light by the early travelers.

Among the ancient arts of the second oldest nation of the earth, on the hazy edge of the old world, they found the Chinese making porcelain and jealously guarding the secret said to have been discovered during the Han dynasty, the Golden Age of China, which began in 206 B.C.

It is probable that Chinese porcelain first came under European eyes during the Crusades in Palestine and Syria. No doubt a limited number of specimens, mainly of celadon ware, found their way into Europe during the 14th and 15th centuries from Syria and Egypt, whither they were brought by the swaying camel train from Asia.

When Europeans, probably the Italians, first saw the Chinese ware, they called it porcelain from the resemblance of its polished surface to that of the Venus shell named Porcella, while the shell itself derived its appellation from the curved shape of its upper surface resembling the back of a "Porcella" or "Little Pig."

No considerable importation of Chinese porcelain took place until the Portuguese merchantmen succeeded in doubling the Cape in the 16th century and capturing the seaborne trade with the Far East. No sooner were the western potters familiar with the beautiful Oriental ware than they set out to imitate it; and at Venice in 1519, if not earlier, an artificial porcelain was produced.

Another account gives the date of the earliest specimens of European

imitation of porcelain as 1575. A few pieces are said to have survived from the productions of a kiln established at Florence. This famous Florentine porcelain was, however, entirely different in its nature and composition from that of the Chinese. It was made by mixing together an impure china clay, fine white sand and a large portion of glass. The pieces now seen in museums are rather thick and clumsy in substance; the glaze is not very brilliant; and the body is only moderately translucent. The decorations are always in underglaze blue, sometimes bright, sometimes rather gray, but always softened and a little run by the glaze. The designs almost invariably take the form of floral arabesques. It seems probable that this porcelain was an experimental one, abandoned as soon as the whim of its patron changed, and it cannot be said to have any influence on the subsequent course of European pottery.

Prof. Binns states that the entry of true porcelain into Europe was not until the early 18th century, when a chemist of Saxony discovered the secret.

Far greater development was reached in the pottery and porcelain of the later 17th and 18th centuries, which are not dealt with in this paper.

REFLECTIONS UPON ART AND MANUFACTURE[1]

By Ellsworth Woodward

ABSTRACT

The writer is struck by the interesting fact that in all manufactured articles in which there is an appeal to taste, those articles sell best and bring the highest return in money which possess the imprint of art. A truly beautiful thing increases rather than diminishes in value. Objects of pure utility, making no appeal to taste, are priced according to the exigencies of competition. They possess no added value, recognized as inherent in art. It would seem that the recognition of this intangible quality, which differentiates a beautiful and at the same time useful thing from that which is purely useful, but possesses no beauty, might be a subject of very great interest for a manufacturer. The great mass of the purchasing world is content to pay the higher price for the article which stimulates his imagination and affords him pleasure.

The other day I chanced upon a piece of old English earthenware among the miscellaneous offerings in a Royal Street shop of an antiquarian. I bought it on an irresistible impulse in spite of the price, which my sober judgment would have rejected as preposterous had a pitcher for merely practical use been in question. There ought to be something of suggestive value in this happening for makers of earthenware, for I am by no means a joyous spender of money.

The point is, this little pitcher is lovely. It affords me delight when I see it out of all proportion to the use it has as a container. I would not

[1] Recd. Jan. 23, 1925. Presented at the Annual Meeting of the American Ceramic Society, Columbus, Ohio, Feb. 1925. (Art Division.)

part with it even at a premium. Surely there is a stimulating idea in this if only the writer could make it clear and be credited at the same time as a sober citizen seeking only to be useful to that great body of workers whose craft he so much admires.

As a life long seeker and follower of the Ariadne thread of beauty through all the works of Man, it has been my privilege to linger as a student in practically all the museum collections of the world. In all of these ceramics has an honored place, and so arranged that one sees how the unconscious play of the potter's artistic faculties creating a thing of beauty while observing the limitations set by use, changes to the conscious, ordered style of craftsmen stimulated by the approval and rewards of kings. One started on a tour of contemplative study, soon discovers that ceramic art has always been a responsive medium for the expression of beauty. Ambitious rulers have realized its possibilities and established great laboratories of artistic endeavor under royal patronage, not always with the hope of financial profit, but as a means of exchange as friendly compliment or in smoothing diplomatic relations. Pottery and porcelain were precious things possessing under these conditions a value immeasurably beyond utility of service. Almost fabulous value it would seem sometimes, for private collector and museum curator openly gloat over their treasures and tell us without apology the prices at which they are quoted.

Finally, as our studies progress, we begin to understand and approve the justice of the high esteem in which certain designs and colors are held and are ready to inquire into the mystery. Why do collectors struggle for possession of certain examples of style and period or the work of an individual craftsman, while other wares remain merely crockery to the end of their existence and pass unmourned into the limbo of the trash-dump?

Your inquiry will lead you inevitably to art as the explanation. Art which combines form and color into a whole—the whole which is a joy forever. Science which guides us so definitely today was, in the past when many or perhaps most beautiful triumphs of the art were made, only present as an accumulation of experience not understood but recognized as operative; for if the combination was inaccurate heartbreaking loss was the penalty. But, and this is the point, the incomparable value of beauty was there in rich abundance. This was no accident for the craftsman was an artist.

It is a commonplace of knowledge that our age is one of scientific achievement beyond all competition from other forms of intellectual endeavor. From this unquestioned state has grown a quite natural pride and preoccupation to the exclusion of appreciation and even of the power to understand other and greater forces.

It is true, though rarely comprehended and perhaps difficult of comprehension, that the only permanent thing in this changing world is spirit.

Things of pure utility serve their purpose, wear out and are forgotten. Those other things to which have been added the mysterious quality of beauty are cherished even in their shattered old age. The foregoing is a statement of sober fact, and yet so holden are our eyes in this age of glittering, material achievement that we refuse to understand.

My parable reciting my encounter with the little pitcher with green leaves floating on a sea of deepest blue will be understood by a few. I am hoping that some young, courageous manufacturer of ceramic ware in quantity production, may also understand and understanding put all to the hazard. With good sense as well as courage, he could become the merchant prince of his age. Really art is the most practical asset of the manufacturer, even when misused; when applied in full measure of skill and understanding the product is without rival.

Newcomb Pottery
New Orleans, La.

COMMON STONEWARE DECORATED BY THE CHINA PAINTER'S PROCESS[1]

By Arthur M. White

The old saying that "it is hard to teach an old dog new tricks" has probably been considerably overworked, but no doubt contains a germ of truth, and used with a reverse English, might apply as an excuse for this paper, which is offered without any apology at the instance of Prof. Cox of the Iowa State Agricultural College, who was good enough to make some kind remarks concerning some pieces of decorative pottery produced by the writer several years ago, who at that time was actively interested in the manufacture of stoneware at Fort Dodge, Iowa. Referring to our observation would say that to one who has spent most of his earlier years in mastering the various problems as they pertain to the manufacturing of clay goods and having the inspiration of three generations of ancestors who were engaged in the same occupation, one finds it almost impossible to forget that early training; hence this paper.

For the benefit of those who might not be familiar with the manufacture of stoneware, it might be said that stoneware has been defined as that kind of pottery which is made from a natural clay and whose firing and glazing is accomplished in one operation. It is always glazed and generally it is vitrified in body texture.

The pieces produced at that time were made from the stoneware clays found in abundance in this locality. The clay was prepared by washing in the usual manner and the articles were mostly hand-turned and consisted of pitchers, jugs, vases, tobacco jars, steins, etc., also some medal-

[1] Presented at the Annual Meeting of the American Ceramic Society, Columbus, Ohio, Feb., 1925. (Art Division.)

lions, which were molded. The designs were applied to the dry or green ware in outline, free hand, and then scratched out with a pointed instrument; all rough edges were carefully smoothed out. The ware was then carefully dried and fired once as bisque ware, along with other stoneware.

After the initial firing the pieces were carefully gone over and all imperfections removed as far as possible, and treated to the regular dip of transparent glaze, which retained the natural straw color of the clay, after the second firing. Regular china colors were applied by Mrs. White, who had received training as a china painter, and who was responsible for all the decorative effects. She also modeled some of the handles. The last and final firing was accomplished in an oil burning studio china kiln.

These wares, having been subjected to the high temperatures of a stoneware kiln, were practically vitrified, and when struck, gave out a sharp, metallic ring, and were both grease and acid proof. Some good, underglaze effects were produced by using a black oxide of cobalt, with a suitable flux for the designs, and then applying the glaze and firing only once.

It can readily be seen that the beauty of this ware is mainly dependent on the artistic ability of the decorator, as well as the selection of designs suited to the size and shape of the pieces, in order to secure that harmony of color texture and line so pleasing to the connoisseur.

The pottery above referred to was destroyed by fire some years ago and the work of the writer along this line necessarily terminated and about all that is left of these experiences are some very pleasant recollections and a modest collection of ware. If the experiences of the writer, as outlined in this rather brief and hastily composed paper, have been honored with your interest and attention, I shall feel well paid for the effort.

FORT DODGE, IOWA

DISCUSSION ON "OBSERVATIONS ON PINHOLING IN CAST WARE"[1]

PAUL E. COX:[2] Professor Binns taught his students to paint the molds with the slip before pouring the slip into the molds when casting wares for use as test pieces in the laboratories. This process prevented pinholing. I accepted this process as one in common use in English plants, since Prof. Binns had at that time but lately come from the Royal Worcester Porcelain Factory. I know that a little work with a brush saves much patching of surfaces in the casting of small vase forms.

While I cannot formulate an answer to Mr. Hemphill's questions, I would say that a painstaking review of the literature to date and some

[1] Paper by R. W. Hemphill, *Jour. Amer. Ceram. Soc.*, **8** [3], 145 (1925).

[2] Iowa State College, Ames, Iowa.

laboratory work in the plant and under plant conditions would yield the answers. Determinations of the properties of the clays and other raw materials of the slips in question would point the way.

W. KEITH MCAFEE:[1] I will not attempt to answer the question asked in the last part of Mr. Hemphill's excellent paper. There are several points I would like to raise, however.

Mold condition, no doubt, has a very great deal to do with pinholing. As Mr. Hemphill points out, damp molds will increase this trouble. Cold molds and new molds are also bad in this respect. The latter probably because of the slick surface, which can be largely counteracted by properly sponging the casting surfaces. "Soft" molds tend to eliminate pinholes, but are usually impractical.

It seems to me that these conditions have to do more with the cure of pinholes than the prevention. We mean by pinholes, I take it, small round holes penetrating the surface of ware to varying depths, and probably caused by trapped air, and possibly in some cases, by shrinkage. Assuming that these are caused, for the most part at least, by trapped air, either due to incorrect pouring of the molds or air in the slip itself, the condition of the molds will either help to eliminate this air, or hold it at the surface, as pointed out by the author.

We have found that the rate of, and method of, pouring molds has a great deal to do with this trouble. The slip should not splash, should be poured in a slow, even stream and, where possible, allow the mold to fill from the bottom up.

A great deal of trouble was experienced with pinholing about a year ago, and investigation disclosed several sources of air in our slip distributing system. In our system, the finished slip is run from the lawns to storage cisterns by gravity. It is pumped from there to open tanks on the roof of the casting shop. Both the cisterns and slip tanks are provided with agitators. The slip flows by gravity through pipes to the various casting benches where it is drawn off through hose and introduced directly into the molds.

A worn stopcock on the suction side of the slip pump was replaced. The slip was fed to the tanks on the roof from the top and dropped some distance into the tanks when they were empty. The piping was changed to introduce the slip from the bottom. All the agitators were slowed up so that there was no splashing at any time. The blades of the agitators were warped slightly to give the slip an upward motion as they revolved.

These changes immediately brought about a great improvement. The casters were required to draw off a bucket of slip immediately before they

[1] Cambridge Sanitary Manufacturing Co., Cambridge, Ohio.

started to pour, and bleeder valves were placed at various points on the slip pipes. These valves are opened before pouring starts, and air allowed to blow off until slip begins to flow. It is surprising how much air can be drawn off in this way.

One of the most important remedies for pinholes is the method of finishing. Mr. Hemphill brings out this point. I sometimes think that all ware has some pinholes which will invariably show up if the finishing is not correctly done and at the right time. This point has been lately brought forcibly to our attention. We stick the rims on our closet bowls with a roll of pugged clay. If this is not worked down properly, it will be fairly peppered with pin holes. They are very fine, and practically impossible to detect either in the green or biscuit stage, and only show up in the gloss ware. This seems to be purely a question of finishing.

Pinholing is a trouble everyone seems to have more or less. They are sometimes nearly $^1/_{16}$ inch in diameter and run clear through a piece of ware $^1/_2$ inch thick. They seem to be most prevalent in single cast ware, or hollow cast ware, which is nearly the same thing.

DISCUSSION ON "THE ELECTRIC BRASS FURNACE REFRACTORY SITUATION"[1]

MEMBER: What watt-loss is permissible before one would consider replacing the lining? What is the proportion of the energy lost through the refractories as compared to the total energy consumed? In other words how do you know when to tear the lining out?

E. L. MACK: A computation of that would depend largely upon conditions of melting whether melting eight hours or twenty-four and what you are melting. It would be hard to say offhand. We can say in a general way that you get to a point in lining life where the energy loss through the refractories is so great that the *average energy consumption over the whole period of lining life* will be 10 or 15% higher than that obtained in the first heats on a new lining. This is caused by increased heat conductivity of the lining due to metal penetration. Obviously a point exists at which it will pay to renew the lining even though the old one is in good mechanical condition. Beyond this point the cost of a new lining is not being saved; it is being paid to the central station for warming the atmosphere in the vicinity of the furnace. For any particular case the locating of this point should be a matter of experiment based upon complete melting data obtained under average foundry conditions.

[1] H. W. Gillett and E. L. Mack, *Jour. Amer. Ceram. Soc.*, 7 [4], 288(1924). Discussion presented at Atlantic City Meeting, Feb., 1924. (Refractories Division.)

CHAIRMAN LYON: This paper is an illustration of what the metallurgist has in mind when he says we are in need of better refractories. As you probably understand it may be possible for the metallurgist to develop a process but if he has not a refractory that will stand the requirements right there he stops. One of the objects of this discussion is to acquaint the ceramic engineer and the manufacturer of refractories with the metallurgical requirements of refractories.

MR. CROSBY: In the application to the non-ferrous melting industry of the Detroit electric furnace we have in the past encountered a great many refractory problems. Those problems seem as far as the non-ferrous industry is concerned to be thoroughly solved. Metal production on the order of 2,500,000 pounds per lining is not at all unusual and we will average one and one-half million pounds on refractories on red brass alloys; on yellow brass alloys the figures show higher refractory life than most others.

We have furnaces in satisfactory operation on nickel-silver and have been able to show on the manufacture of synthetic gray iron a lining life comparable to that of the cupola or similar metallurgical equipment which is fairly a good result. For the brass furnaces we are using refractories from two or three standard sources. These are of the highly aluminous class and are made up in standard blocks. In fact that is perhaps the solution to our lining problems. We have made these blocks in various sizes to fit the various furnaces. At one time I was imbued with the idea that I would like to have a one-piece cylindrical lining and still would if I could get a ceramist that would give me one which would be satisfactory. We went a step too far in that direction, however, by making our blocks so large that they cracked, and have gone back to smaller sizes. The furnace size in the 750-pound Detroit furnace for instance is a circle block which is about ten inches square and four and one-half inches thick.

A great deal has been done in the development of patching material which also helps us to improve our lining life. Scrap metal contains considerable siliceous and other non-metallic material and the erosion and chemical reaction tend to chew up the lining rapidly. We believe one of the peculiar advantages of the moving indirect-arc furnace is that it is extremely easy to patch.

Our furnace is nothing more or less than a hollow cylinder and is so designed that patching may be applied readily either from the electrode portholes or from the door.

We would be highly interested, in fact the thing that is attracting more attention at the present time from our engineering department than anything else is the development of a refractory lining for our furnace for use in the manufacture of synthetic gray iron.

It is rather difficult to make a magnesite lining stick in our type of furnace and we have tried a great many mixes which have been suggested by several prominent ceramists with very unsatisfactory results. We would be intensely interested in a refractory which could be applied in a cylindrical furnace readily and stand up under the melting of iron borings and turnings. I believe there is a tremendous market for that type of equipment. In fact, I am positive that we have a demand for several furnaces that could be supplied immediately if we felt there was a refractory which we could unhesitatingly state would last from four to five hundred heats on gray iron. Unfortunately I know of no such refractory. I am confident that so far as refractories for non-ferrous work are concerned our troubles are behind us. They have long since been solved for our furnaces.

D. A. Lyon (Chairman): The field of usefulness of the induction furnace could be much extended if suitable refractories were developed for such a furnace. So far the consumer has done the talking on this subject. The ceramist should have something to say. At a similar symposium last year at Pittsburgh those of you who were there will remember that the refractories people did all the talking and we could not get the consumer to say anything. The metallurgical industry today and, especially the electric furnace phase of it, is up against it so to speak for refractories that with meet the requirements. As Dr. Mack said, what is needed is not merely a refractory that will stand high temperatures. The requirements are very much more than that.

E. L. Mack: There is one other thing I would like to hear discussed. That is the possibility of producing what, for want of a better name, we call a "graded or laminated" refractory. I think Dr. Gillett has previously talked about this possibility before this and other societies. The idea is to attempt to make use at the same time of the excellent refractory properties of carborundum and the good mechanical and thermal properties of fire clay by working out a refractory having a continuous variation in composition from pure fire clay on one face to bonded carborundum on the opposite face. Actually this would very likely work out as a piece built up from layers of increasing carborundum content as the working face is approached.

It is recognized that the ceramic problems to be encountered in the production of such a refractory would be stiff ones but it is felt that the usefulness of the product would justify the effort. A successful development along this line would make available a refractory of fairly good thermal resistance, good mechanical properties, and superior chemical resistance. It would have a certain field of application awaiting it in the brass-melting industry and very likely additional fields in other metallurgical industries, with which I am not so familiar.

DISCUSSION ON "PLASTIC PROPERTIES OF ENAMEL SLIP"[1]

R. D. Cooke: The mobility increases in a linear manner with the solid content and has a concentration of zero mobility. At the concentration of zero yield point the mixture passes from a liquid to a solid. These methods should give valuable results in determining the suitable clays for enameling purposes with reference to their ability to suspend the enamel and provide good operating consistency.

H. F. Staley: Mr. Cooke has touched on a rather vital point in regard to enamels. The determining or measuring in quantity the properties of enamel clays is one of the most difficult and obtuse problems we have. About the only way we have at the present time of trying out a clay is to put it in the enamel and if it works, it works, and if it does not work, we set it aside and keep it as an exhibit.

Mr. Cooke in his method states that if the clay does not work he not only finds out why it fails to work but he may be able to add something which will make it work. Therefore this paper is of real practical value to the enamelers.

R. R. Danielson: Do you make the determinations on the enamel slip as it is used in the shop or do you have to thin it down?

Mr. Cooke: It is made on the enamel as it is used.

R. R. Danielson: I think Mr. Cooke has done a mighty fine piece of work. Those of us who tried to use the old apparatus for making determinations for the setting up of enamels have found it of practically no value. The Bureau has done considerable work on clays. They have had the problem whether the Bingham apparatus could be used. Because of the comparative coarseness of the enamel particles they could do nothing with it. Mr. Cooke has been very ingenious in devising an apparatus which gets around the objection of the present Bingham apparatus.

R. D. Landrum: This gives us another method of making a standard for our shop practice.

There are some hundred places in the enameling process where things can go wrong. And for those one hundred places we have only four or five standards, because we have only four or five things that we can actually measure. In the manufacture of table tops we not only have to put the enamel on, but we have to put it on quickly. Production is essential. We do not want to take the time to spray. Our idea would be simply to have a machine that would put this table top through the enamel, drain and dry it and then on through the furnace. Our need is a continuous process.

What is the defeating factor in having the slip the same today, to-

[1] R. D. Cooke, *Jour. Amer. Ceram. Soc.*, 7 [9], 651(1924). Discussion presented at the Atlantic City Meeting, Feb., 1924. (Enamel Division.)

morrow and the next day? Five table tops dipped by the same girl in exactly the same tank will be found to have a variation of 25% in the weight of enamel on the tops.

Mr. Cooke has given a method and a machine that any enameler can rig up and interpret the results. He can find how to make that slip always work the same. With these ideas we can find a method of keeping the procedure uniform.

B. T. SWEELY: There is just one phase which Mr. Cooke has brought out but on which no one has as yet touched and which is of vital importance to the man who is spraying ware. You will find that the sprayed piece of ware leaving one operator is perfectly smooth while on that from another operator the enamel will pile up no matter how you set that gun. In other words instead of being a perfectly smooth coat it looks rough as though the operator had held his gun too close. It makes no difference where you hold the gun you will get that effect.

I believe the yield point as Mr. Cooke describes it in this test is the key to that situation—the thing that we have all been seeking, trying to get—a uniform and smooth coat of enamel on a piece of ware under the average spraying condition.

In my own shop that is one of the most troublesome things with which I have to deal. We set the enamel in the time-honored practice of sticking a finger into it. Look at your cull pile and you will see why such a test is no test at all.

The question of keeping your slips under control is a very acute problem in the shop. I worked for some eight months trying to standardize slips. I never succeeded in doing it. I was trying to standardize viscosity. I think Mr. Cooke has at least hit on something that will give us a real start on the question of standardizing our enamel.

H. F. STALEY: This question is of interest not only to the wet coat enamelers but also to those who do dry coat enameling, because in getting a uniform ground coat on the casting either by spraying or slushing or pouring enamel, the ground coat is very liable to run down and collect in heavy beads at edges and in certain other spots, which causes blistering.

ART DIVISION QUESTION BOX

MARGARET KELLY CABLE, EDITOR

In conducting a Question Box, it is the aim of the Art Division to serve not only the members of its own individual division, but also the members of any of the other divisions to whom it may be of service.

This being a new venture for the Art Division, we do not know the best and wisest way to proceed. We are going to begin, however, by

publishing from month to month a list of contributed questions with a discussion of one or more, as space permits, by some well-informed person.

Our initial list of questions is rather meager but we wish to get going. We want you to know *first* that there is such a thing as an Art Division Question Box and *second*, we want you to help make it a success by allowing us to serve you. The true measure of our success will be in direct proportion to the real value of our service.

Please do not hesitate to send in that perplexing question, or any new or helpful suggestion. Discuss it yourself and we will endeavor to supplement your discussion with the viewpoint of others.

Address all communications to Margaret Kelly Cable, University Station, Grand Forks, North Dakota.

Questions

1. What is the best way of preparing clay for a school having no clay washing and clay preparing equipment?

2. Is there a light burning clay which burns dense at cone 1, for example, and where may it be bought prepared for studio use?

3. Where do such schools as are listed below purchase their clays? Are they bought wet or dry?

The Lewis Institute and the Art Institute of Chicago, the Cleveland School of Art, the Museum School of Industrial Art, Philadelphia, the Museum School of Fine Arts, St. Louis, the Newcomb School of Art, New Orleans, Schenley High School, Pittsburgh, the Normal Art Department, University of Wisconsin, and the University of North Dakota.

4. I have had difficulty since the war in securing flat potter's sponges. Where may they be obtained?

5. What is the relative difference in the cost of purchasing glazes ready for use and making up one's own, provided one has the equipment?

6. Is there any way that a porous biscuit body may be made waterproof except by glazing? For example, many small schools have no kilns or firing facilities near at hand and yet would like to render the pieces, fashioned of local clays by the grade school children, waterproof. These pieces could be biscuited at a low temperature in an open fire much as primitive wares are baked. The teacher from whom the inquiry comes would like to know if there is any simple method of treatment or preparation which could be applied to the inside of such wares to make them waterproof?

Reply to Question 1. By Frederick H. Rhead.—I would suggest the installation of a simple, 25-gallon barrel churn, costing about $12.00. A small motor would cost from $15.00 to $20.00. The churn can be driven to operate about 55 revolutions per minute.

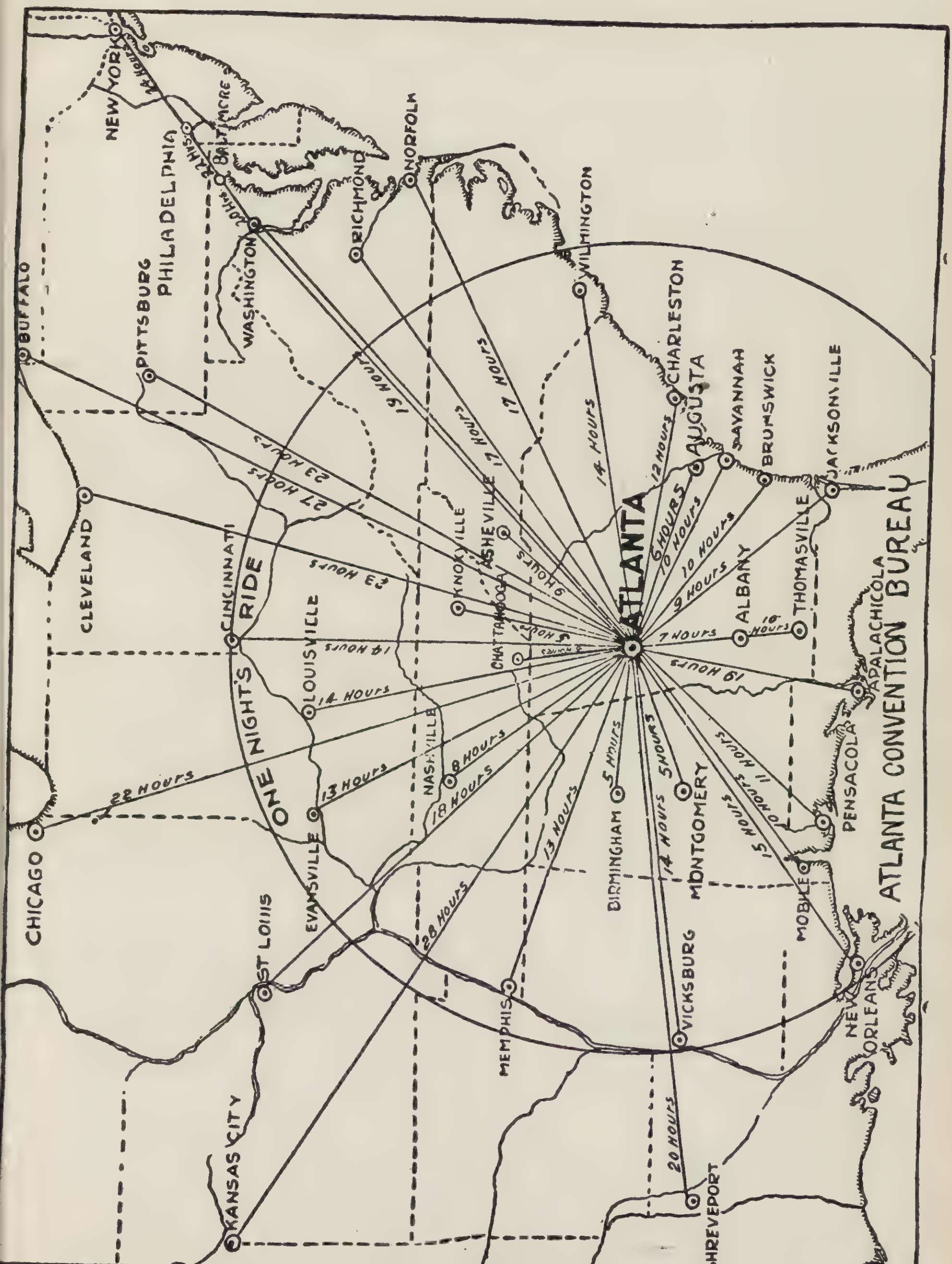
The clay mixed with about 50% of water would be placed in the churn and operated for four or five hours. The resulting slip would be run through a 60-mesh sieve and then poured in plaster troughs until the surplus water was absorbed. The clay would then be wedged or kneaded to an even consistency.

Such a process could be reduced to a mere routine. Students should assist in this work not only as a matter of convenience but they should know how to prepare clay.

The 25-gallon churn will mix approximately 100 pounds of clay and as this can be done in about four hours, the needs of an average size school can easily be met.

ACTIVITIES OF THE SOCIETY

OUR GEORGIA MEETING



February 8–13 inclusive, 1926, is the time the members of this SOCIETY will spend in Georgia. Words from the Georgian ceramists and from the Chambers of Commerce in Atlanta, Macon, Gordon and MacIntyre are to the effect that nothing humanly possible will be left undone to make our Meeting in their state most profitable.

The technical sessions will be held in Hotel Biltmore, Atlanta on Monday, Tuesday, Wednesday and Thursday.

The Woman's Club has promised a regular "cut up" evening with a musical farce and a dancing party "what am." A banquet royal also awaits.

On Thursday afternoon a special train will move the entire party to Macon. Comfortable hotels, modern in every respect and of ample capacity will house us for the night but not until after the Macon folks have shown us a bit of banquet hospitality in true southern style.

Friday morning early we again board our special and go eastward. A portion of the party will go direct to Stevens Pottery where they make fire brick, sewer pipe and clay specialties. The remainder of the party will go direct to MacIntyre.

Have you ever been to Klondyke? You will on this trip and that too with the Edgar brothers. Other clay preparation plants, most novel, are in MacIntyre.

Then about noon both parties will travel back westward to Gordon, the four cornered ceramic metropolis of Georgia. In Gordon we will see a modern porcelain brick plant and several clay washing plants, that is, if we are not loaded to the gills with barbecued partridges, etc. They say the Gordon crackers are right there on barbecues. Even now their mouths are watering in anticipation of our being with them. And some brick plant you will say. Bauxites and clays galore.

Then Friday evening our special will take us back to Macon where we again will be received royally and again enjoy their comfortable hotels. Saturday will be spent with the Maconians and some spenders are they. You will have a chance to see clay mines and washing plants and the extensive clay working plants of our fellow member Dunwody.

This hurried sketch of the week as planned by the Georgians does not make mention of the many historical and ceramic points of interests, each of which you will remember with profit and pleasure. A grand time, a profitable meeting and the extreme of hospitality awaits us at our Annual Meeting in Georgia next February.

NEW MEMBERS RECEIVED FROM MARCH 15 TO APRIL 15

PERSONAL

J. Atwood Austin, 1942 Iuka Ave., Columbus, Ohio. Student.
Willi M. Cohn, P. O. B. 161, Haifa, Palestine. Managing Director of the Kishon Clay Works, Ltd.
Clark M. Dennis, 233 Broadway, New York City. Chief Chemist, Technical Service Dept., American Trona Corp.
Myrtle Meritt French, Art Institute of Chicago, Chicago, Ill. Teacher of Pottery.
Jane Hoagland, 206 Quincy St., Brooklyn, N. Y. Artist Potter.
William J. Murphy, 233 Broadway, New York City. Borax Salesman, American Trona Corp.
William J. Spielman, 229 Hamer St., Clyde, Ohio. Enameler.
Walter Steger, Im Eichkamp 46, Berlin, Grunewald, Germany.
W. D. Woolley, Carey, Ohio. President, The Carey Ohio Porcelain Co.

CORPORATION

Ingram-Richardson Corporation, Bayonne, N. J. J. R. Burt.

Membership Workers' Record

	Personal	Corporation
R. D. Landrum		1
Mary G. Sheerer	2	
Ira E. Sproat	1	
Office	6	
Total	9	1

LIST OF STANDING COMMITTEES, 1925-26

Publication
Forrest K. Pence, *Chairman*
Francis C. Flint
Miner L. Hartmann
W. E. Dornbach
M. C. Booze
E. C. Hill

Tests
C. F. Binns
E. P. Poste
R. F. Brenner
A. V. Henry
G. A. Bole
C. W. Hill
Geo. Sladek

Rules
L. E. Barringer, *Chairman*
M. F. Beecher
J. D. Whitmer
S. R. Scholes
W. J. Stephani
Arthur Baggs
R. R. Danielson
W. D. Richardson
W. E. Dornbach
W. A. Hull
E. H. Fritz

Membership
——————*Chairman*
Fred B. Ortman
Hewitt Wilson
Charles F. Geiger
Ray T. Stull
R. A. Weaver
J. M. Hammer
R. A. Horning
Geo. P. Fackt
I. E. Sproat

Standards
R. F. Geller, *Chairman*

Definitions
A. S. Watts
M. F. Beecher
J. S. McDowell

Raw Materials
D. W. Ross
H. F. Staley
E. W. Washburn
F. G. Jackson
R. F. Ferguson
H. G. Schurecht
A. V. Bleininger

Products
F. H. Rhead
A. E. Williams
Hewitt Wilson
W. L. Howat
Robt. Twells, Jr.

Sections and Divisions
A. Silverman, *Chairman*
E. P. Poste
A. F. Hottinger
F. L. Steinhoff
F. T. Owens
Mary G. Sheerer
M. E. Manson
A. Silverman
John D. Martin
C. E. Bales
E. C. Hill
F. H. Riddle

Research
W. M. Clark, *Chairman*
A. V. Bleininger
A. R. Payne
R. L. Clare
R. R. Danielson
F. H. Rhead

Papers and Program
Ross C. Purdy, *Chairman*
H. Clinton Baldwin
H. G. Wolfram
A. N. Finn
A. P. Potts
L. C. Hewitt
G. M. Tucker
F. H. Rhead

Geological Survey
S. L. Galpin, *Chairman*
H. Ries
A. M. Campbell
W. G. Worcester
G. A. Bole

Data
C. W. Parmelee, *Chairman*
H. S. Kirk
T. D. Hartshorn
J. W. Cruikshank
R. E. Arnold
D. W. Ross
T. A. Klinefelter
E. Schramm

Ceramic Education
W. Keith McAfee, *Chairman*
Edna P. Carson
R. D. Landrum
H. W. Hess
H. R. Straight
A. F. Hottinger

PERSONAL NOTES

Y. R. Anderson, formerly of Young, Saskatchewan, Canada has moved to St. Louis, Mo., where he is employed by the Evens & Howard Fire Brick Co.

Randolph H. Barnard of the Illinois Glass Co. of Alton, Illinois has been transferred to the Gas City, Ind. plant.

Richard S. Bradley of Bement, Illinois has moved to Mexico, Mo.

George H. Duncombe of Columbus, Ohio has recently become affiliated with Mellon Institute, Pittsburgh, Pa.

Roland J. Gouin, Plant Chemist for the Illinois Glass Co. of Alton, Illinois has moved to Claremont, N. H.

Victor V. Kelsey has moved from Knoxville, Tenn. to Washington, D. C.

R. D. Landrum, past president of the SOCIETY, is now identified with the Titanium Alloy Mfg. Co., Tenbusch Bldg., 6007 Euclid Ave., Cleveland, Ohio.

F. A. McCann, who has been affiliated with Mellon Institute, Pittsburgh, Pa., is now with the Pacific Clay Products, Inc., Los Angeles, Calif.

J. G. Phillips, who has been connected with the Research Laboratories of the Standard Oil Co., is located at the U. S. Bureau of Mines, Columbus, Ohio.

Fred W. Runge, Chemist for the Josiah Anstice & Co., Inc., Rochester, N. Y., is now located with the Ferro Enameling Co., Cleveland, Ohio.

Victor N. Yingling has moved from Columbus, Ohio to 318 N. Duke St., Lancaster, Pa.

LOCAL SECTION NEWS

Baltimore-Washington Section[1]

The fourth and last meeting of the Baltimore-Washington Section for the 1924–25 season was held at 7.00 P.M. Saturday, April 7th, 1925, in Washington, D. C. The usual dinner was enjoyed.

Dr. Kurd Endell of the Technische Hochschule, of Berlin, Germany gave a paper on "The Thermal Expansivity of Refractories." Dr. Endell gave us an insight into some of the peculiarities of expansion which take place in some refractories.

Dr. J. W. Greig of the Geophysical Laboratory, in his paper on "The Formation of Mullite from Cyanite, Andalusite and Sillimanite" showed that the formation of mullite takes place at definite temperatures for these materials.

Dr. Endell and Dr. Greig used lantern slides to illustrate their papers.

These two speakers were followed by Mr. H. F. Staley of the Metal and Thermit Corp. Mr. Staley addressed us on "Pottery and Enameling Practice on the Pacific Coast." His explanation of some of the ingenious devices used by our Western brothers was somewhat handicapped by the lack of a blackboard, but he easily overcame this and made us understand the workings of these devices.

Following the speakers there was an election of officers for 1925–26. The following were elected:

R. R. Fusselbaugh, Chairman, Baltimore Enamel & Novelty Co.
P. H. Bates, Vice-Chairman, Bureau of Standards
D. H. Fuller, Secy. and Treas., Bureau of Standards
Karl Langenbeck, Councillor, Bureau of Standards

After the election the meeting adjourned. The next meeting to be held in Baltimore, on October 3rd, 1925.

[1] Reardon Fusselbaugh, Secy.

Chicago Section Meeting

The members of the Chicago Section held their April meeting on the 14th at the club rooms of the Western Society of Engineers. The success of the meeting was immense and the members proved that a local section can produce a program equal in caliber to the Annual Meetings of the SOCIETY. The following papers were presented at the afternoon session and each one was followed by a spirited discussion:

1. "Role of Air in Plastics," by Harry Spurrier.
2. "Manufacture of Eversharp Leads," by Robert Back.
3. "Ceramic Problems in the Manufacture of Telephone Equipment," by H. T. Bellamy.
4. "Data on the Operation of an Oil-Fired Frit Furnace," by B. S. Radcliffe.
5. "New Type of Oxy-Acetylene Fusion Furnace, with Notes on the Behavior of Refractories at Cone 40," by A. F. Gorton and W. H. Groves.
6. "Research Work in Progress at the Department of Ceramic Engineering, University of Illinois," by C. W. Parmelee.

Forty-two were present at the dinner at the Chicago Engineers Club. In the evening the following papers were presented:

1. "Manufacture of Molded Insulation," illustrated with two reels of motion pictures, by R. C. Shuey.
2. "Manufacture of Fine China" (motion pictures), by W. W. Wilkins.

R. D. Landrum represented the Board of Trustees and spoke briefly congratulating the members on their record meeting. The motion pictures films which were shown proved very entertaining.

CHAIRMAN OF ART DIVISION A DELEGATE TO THE PARIS EXPOSITION

A number of ceramists intimately connected with the Exposition of Modern Decorative and Industrial Art, which opens in Paris, in May, will accompany the commission appointed by Secretary Herbert Hoover. Mary G. Sheerer of H. Sophie Newcomb Memorial, will represent the AMERICAN CERAMIC SOCIETY.

Interest in the arts shown at this exposition has been greatly fostered by the attention given to it by Secretary Herbert Hoover who appointed a commission to head the delegation, comprising Dr. Charles R. Richards, president of the American Association of Museums, as chairman, Mr. Henry Creange, the winner of the Friedsam Art and Industry Medal, and Frank G. Holmes of the Lenox potteries in Trenton. The commission appointed Edward L. Bernays, counsel on public relations, as an associate member.

In officially recognizing the importance of this exposition, Secretary Hoover has taken the first step in the government interest in these industrial arts. He called upon the commission to report on such features of the exposition and phases of the individual groups of exhibits, as may be of interest and value to American manufacturers.

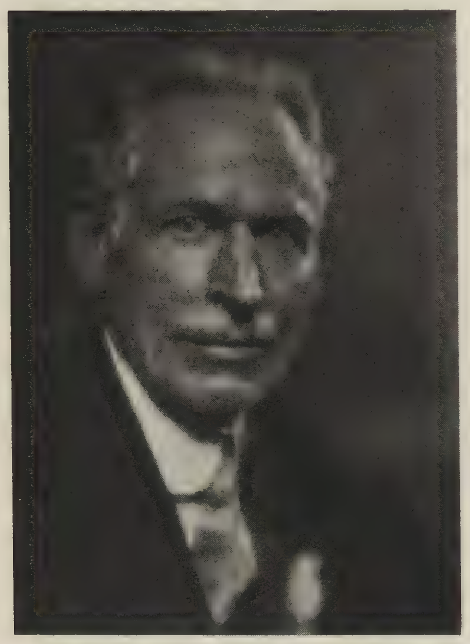
OBITUARIES

Willis E. Cunning

Willis E. Cunning, president of the West End Pottery Company, East Liverpool, Ohio, died on April 4 at the age of sixty-three. Mr. Cunning had long been a member

of the AMERICAN CERAMIC SOCIETY and since 1920 had been corporation representative for this company.

William Shaw George



WILLIAM SHAW GEORGE

William Shaw George, President of the W. S. George Potteries Co., East Palestine, Ohio, and corporation member of the AMERICAN CERAMIC SOCIETY, died in New York City, April 12, 1925. Mr. George was born in East Liverpool, Ohio, March 21, 1865. In 1898, he left the employ of the Ohio China Co., as decorator, to take over the management of the East Palestine Pottery Co.'s plant, which is now No. 4 plant of the W. S. George Potteries. Other plants of this company are located at Canonsburg and Kittanning.

Richard R. Hice

Richard R. Hice died at his home in Beaver, Penna. at the age of sixty. He was a charter member of the AMERICAN CERAMIC SOCIETY and president of same during 1915. Mr. Hice graduated from Geneva College, at Beaver Falls, in 1880 and he was engaged in brick manufacturing for a number of years. In more recent years he devoted a great deal of time to geological survey work in Pennsylvania. He was a large contributor to the Transactions of the SOCIETY.

RICHARD R. HICE

William Henry Grueby

Word has been received of the death of William Henry Grueby, head of the Grueby Faience and Tile Co. of New York on February 23, 1925. Mr. Grueby was intimately associated with the C. Pardee Tile Works, Perth Amboy, N. J. He had been a member of the AMERICAN CERAMIC SOCIETY for a number of years.

George W. Dilks, Jr.

George W. Dilks, Jr., vice-president of the Seaboard Fuel Corporation, Philadelphia, Pa. died on April 16. Mr. Dilks had been the corporation representative for this company in the AMERICAN CERAMIC SOCIETY since 1922.

NOTES AND NEWS

BUREAU OF STANDARDS NOTES

Measurements on the Thermal Expansion of Fused Silica The Bureau has completed measurements on the thermal expansion of representative samples of fused silica (fused quartz) between minus 125°C and plus 1000°C. The specimens were furnished by commercial companies. This research was undertaken for the purpose of obtaining data on the thermal expansion of fused silica for use in thermostats, clock pendulums, length standards, pyrometers, gas sampling devices, acid resisting articles, insulating and temperature resisting devices, etc.

The expansion curves show very interesting results at low temperatures. For each sample of fused silica, a critical temperature (or minimum length) was found. On heating above this temperature the material expands, but on cooling below this temperature, expansion (instead of contraction, as might be expected) also takes place. In other words, the coefficients of expansion are positive above the critical temperature and negative below this temperature. From a consideration of all available results relating to the critical temperature, or minimum length of fused silica, −80°C may be taken as a representative value for the critical temperature of this material. The results at high temperatures are now being studied.

A manuscript giving the results of this investigation is being prepared for publication. This publication will include a review of available information obtained by previous observers on the thermal expansion of fused silica, as well as a detailed description of the apparatus and methods of measurement required for the accurate determination of such minute values of the coefficient.

SOCIETY OF GLASS TECHNOLOGY

A meeting of the Society of Glass Technology was held in Armstrong College, Newcastle-upon-Tyne, on Wednesday, March 18, the President, S. C. Halse, in the chair. Two papers were presented. The first was entitled, "The Use of Zirconia in Glass-Making and the Characteristics which this Substance Imparts," by Violet Dimbleby, S. English, Edith M. Firth, F. W. Hodkin, and W. E. S. Turner (all of the Department of Glass Technology, the University, Sheffield). Prof. Turner, who gave this paper, referred to the statement by Arnold in 1918 that zirconia had a very low coefficient of thermal expansion, namely 8.4×10^{-7}, only little more than that of fused silica. By analogy with the influence of silica in glass, it might be expected that zirconia would reduce the thermal expansion of glasses and assist in the production of glasses of enhanced thermal endurance. Another reason for investigating the use of zirconia was the possibility of making glass distinctly more durable and resistant to alkaline solutions. Zirconia was also being proposed for use as a refractory material, and had in fact, been employed experimentally for very high temperatures. In recent years it had been advocated as a medium for making opal glasses and enamels, but in the experiments carried out at Sheffield it was found that soda-lime-zirconia-silica glasses and soda-zirconia-silica glasses could be prepared with a considerable zirconia content. In the series of general formula $6SiO_2$ (2–x) Na_2O, x ZrO_2, ten per cent, and in the series (6–x) SiO_2, $2Na_2O$, x ZrO_2, twenty per cent of zirconia was introduced without producing opacity. The glasses containing considerable amounts of zirconia were difficult to melt and were viscous like alumina glasses, but with a shorter working range than the latter. The zirconia glasses did not exhibit low thermal expansion. Their anneal-

ing temperatures increased with zirconia content, less steeply than corresponding glasses with basic oxides, such as lime or magnesia. Replacement of silica by zirconia very considerably enhanced the resistance of the glasses toward attack by alkaline solutions.

The second paper was entitled, "The Effect of Composition on the Viscosity of Glass, Part III. Soda-Lime-Magnesia Glasses, and Soda-Lime-Alumina-Glasses," by S. English. Mr. English described experiments he had carried out with a view to investigating the effect on the viscosity of glass of the substitution of alumina and of magnesia at various temperatures between 1400°C and the annealing temperatures of the glasses produced by substitution. As a starting point, a glass of the molecular composition 1.2 Na_2O, 0.8 CaO, 6 SiO_2 was taken and the lime was substituted by magnesia in molecular proportions, 0.1 mol. being substituted at each stage. Throughout the whole range of temperature, from 1400° to below 600°, the replacement of lime by magnesia was accompanied by a reduction in viscosity, a minimum value being indicated for glasses containing approximately equimolecular proportions of the two bases. A further important feature that was evident from the curves in which the logarithms of the viscosity were plotted against composition for this series of glasses, was that the substitution of magnesia caused the rate of increase of viscosity with falling temperature to become more uniform throughout the whole range of temperature. In the series of glasses in which alumina was substituted molecularly for lime, the viscosity of the melts at 1400° showed increased viscosity, the increase being practically proportional to the molecular proportion of alumina both at 1400° and at 1200°. Below 1200° the substitution of 0.1 lime by 0.1 magnesia caused a decreased viscosity so that at 1000° and 800° there was a distinct minimum value on the viscosity composition curve. Like magnesia, alumina has a pronounced effect in rendering the rate of increase of viscosity with falling temperature more uniform.

TESTS OF IMPURE WATERS FOR MIXED CONCRETE[1]

By Duff A. Abrams

Strength tests of Portland cement concrete were made at ages of 3 days to $2^1/_3$ years using mixing waters of a wide range of types, many of which were thought to be unsuitable for use in concrete. Sixty-eight samples of water were tested in two different investigations; 52 samples were collected from different sections of the country; 14 were from the Chicago district. Among the waters tested were sea and alkali waters, bog waters, mine and mineral waters, waters containing sewage and industrial wastes, and solutions of common salt. Tests of fresh waters (including distilled) were made for purpose of comparison. About 6000 tests are included in this report. Reference is made to a number of other investigations on related subjects.

Series 137: 50 samples of water were used in 1–4 concrete of relative consistency 1.10 and tested after curing under the following conditions:

(*a*) Moist room tested at ages of 3 days to $2^1/_3$ yrs.

(*b*) Moist room 28 days, then in air of laboratory, tested at 3 mo. to $2^1/_3$ yrs.

Series 138: 18 samples including sewage and trade wastes from the Chicago district were used in concrete cured in moist room as follows:

(*a*) 1–7, 1–5, 1–4, 1–3, and 1–2 mixtures; relative consistency 1.00, tested at 28 days.

(*b*) 1–4 concrete mix, relative consistency 0.90, 1.00, 1.10, 1.25, and 1.50, tested at 28 days.

[1] Paper before American Concrete Institute; *Proceedings*, 1924.

(*c*) 1–4 concrete mix; relative consistency 1.00, tested at 3, 7, and 28 days, 3 mo., 1 and $2^1/_3$ yrs.

(*d*) 1–3 standard sand mortar, tension tests of briquets and compression tests of 2 by 4-in. cylinders at ages given in (*c*).

Concrete and mortar tests were made in accordance with standard methods. In general, 5 to 10 concrete specimens, and 5 mortar specimens were made in a set on different days.

Time of setting and soundness tests of cement were made with each sample of mixing water.

The principal conclusions from these tests are:

(1) In spite of the wide variation in the origin and type of the waters used, and contrary to accepted opinion, most of the samples gave good results in concrete. This result seems to be due to the fact that the quantity of injurious impurities present is quite small. The following samples gave concrete strengths below the strength-ratio of 85% which was considered the lower limit for acceptable mixing waters: acid waters, lime soak from tannery, refuse from paint factory, mineral water from Colorado, and waters containing over 5% of common salt.

(2) The quality of a mixing water is best measured by the ratio of its 28-day concrete or mortar strength to that of similar mixes with fresh water. While the lowest permissible strength-ratio is a matter of judgment, waters giving strength-ratios which in general fall below 85% should be considered unsatisfactory; if only isolated tests are made, 80% should be the limiting value. The time-of-setting test appears to be an unsafe guide as to the suitability of a water for mixing concrete.

(3) Neither odor nor color are any indication of quality of water for mixing concrete. Waters which were most unpromising in appearance, gave good results. It may safely be said, however, that any natural water which is suitable for drinking can be used without question for mixing concrete.

(4) Distilled water gave concrete strengths essentially the same as other fresh waters.

(5) Bog waters which were thought to be unsuitable for mixing concrete generally contained only small quantities of foreign materials and gave good results. The strength-ratios for the individual samples were seldom below 90%.

(6) Sulphate waters produced little or no ill effects until an SO_4 concentration of about 1% was reached. For a concentration of 0.5% the average reduction in strength was about 4%; a concentration of 1% was required to produce a reduction in strength of more than 10%.

(7) Concrete mixed with sea water (about 3.5% salts, mostly sodium chloride) cured in the moist room gave higher strengths than fresh-water concrete at ages of 3 and 7 days; at 28 days and over, the strength-ratios for sea water ranged from 80 to 88%. Air-cured concrete mixed with sea water was lower in strength than similar fresh-water concrete at 3 mo., but showed a recovery in strength at later ages and gave strengths equal to that obtained with fresh water. (In spite of the satisfactory strength results, it seems unwise to use sea water in reinforced concrete construction, particularly in the tropics on account of danger of corrosion of reinforcement.)

(8) Synthetic sea water gave concrete and mortar strengths similar to natural sea water.

(9) Concrete mixed with water from the Great Salt Lake (about 20% sodium chloride) gave strength-ratios from 65 to 77% at ages of 28 days and over. This water is not satisfactory for mixing concrete, unless allowance is made for about 30% reduction in the assumed strength.

(10) Water from Devil's Lake, North Dakota (0.15% sodium sulphate and 0.15% sodium chloride), gave normal concrete strengths and showed no ill effects.

(11) Water from Medicine Lake, South Dakota (3.5% solution of sulphates, largely magnesium; SO_4 concentration 2.8%), gave strengths similar to that obtained with sea water. The lower strength-ratio was 84%.

(12) Waters from drains and small streams in sulphate districts gave satisfactory strengths at ages up to $2^1/_3$ yrs. The lowest strength-ratios were about 90%.

(13) Concrete made with solutions of common salt and cured until test in a moist room showed a slight increase in strength at 3 days for solutions of 10% and less. Solutions of low concentration (1 and 2%) also showed a slight increase in strength at 7 days; after 7 days, however, all concentrations gave material reductions in strength. Strength-ratios as low as 60% were found for a 20% solution at early ages and for 10% and 15% solutions at the later ages.

Concrete made with salt solutions and cured in the moist room for 28 days, then in air, gave results at 3 mo. almost identical with that obtained for moist-room curing. For this curing condition, the addition of salt reduced the strength at 1 yr. about 12%; at $2^1/_3$ yrs. there was no reduction in strength. The apparently conflicting results for moist-room and air-curing have not been explained.

(14) The use of common salt for the purpose of lowering the freezing point of the mixing water during cold weather should not be permitted; 5% of salt lowers the freezing point of water about 6° F, but reduces the strength of concrete about 30%.

(15) Mine and mineral waters gave good results in concrete, with the exception of a carbonated mineral water from Colorado which gave strength-ratios as low as 80%. Pumpage waters from coal and gypsum mines also gave good results in concrete.

(16) Water containing sanitary sewage gave essentially the same concrete strength as fresh water. Water from the Illinois River, which carries sewage from Chicago, gave strength-ratios at 28 days and 3 mo. of 83 and 85% for moist-room curing; for air-curing strength-ratios ranged from 92 to 102%.

(17) Waters containing refuse from oil refineries gave erratic strengths. These samples generally gave strengths near normal, but in some cases material reductions in strength were found. Setting time of cement with one water sample was: initial 10 hrs., final 42 hrs.

(18) "Bubbly Creek" water, which is highly polluted with wastes from the Chicago Stockyards and gave off an offensive odor showed strength-ratios of about 100% for all ages, mixes and consistencies.

(19) Tannery wastes generally gave reductions in concrete strength; the lowest strength-ratios were about 80% (lime soak water).

(20) Brewery and soap works wastes gave concrete strengths essentially the same as that of fresh water.

(21) Waste from a gas plant and a corn products factory gave good results; the strength-ratios ranged from 90 to 100%.

(22) Paint factory waste water gave strength-ratios ranging from 80 to 90%.

(23) A spent plating bath containing sulphuric acid, after dilution to 10 and 20% of its original concentration, gave strength-ratios as low as 85% for the 10% solution and 74% for the 20% solution. For different consistencies both solutions gave about the same strength-ratios which ranged from 88% to 106%. Lower strength-ratios were obtained with the rich concretes than with the lean.

(24) The strength of concrete mixed with all samples of impure waters showed normal increase at 28 days with additional quantities of cement. The impure waters gave about the same strength-ratios regardless of the mix used in the concrete tests.

For the usual range in mixtures (1–5 to 1–4) the strength increased about 1% for each 1% additional cement.

(25) There was a marked reduction in strength of concrete with increase in quantity of mixing water both for fresh and impure waters. Increasing the quantity of mixing water 1% reduced the strength of concrete about the same amount as if the quantity of cement were *reduced* 1%. A comparatively slight increase in *quantity* of mixing water produced a greater reduction in concrete strength than that caused by the use of the *most polluted* mixing water that is ordinarily encountered. These tests show the importance of the water-ratio strength relation in concrete which has been pointed out in numerous other reports from this Laboratory.

(26) The effect of impure waters was in general independent of the consistency of the concrete. Acid waters from a spent plating bath gave somewhat higher strength-ratios in the wetter concretes.

(27) The strength of concrete cured in a damp condition at normal temperatures increased with age for both fresh and impure waters. The strength was approximately proportional to the logarithm of the age at test.

(28) The effect of impure mixing waters on the tensile and compressive strength of 1–3 standard sand mortar at ages of 3 days to $2^1/_3$ yrs. was generally similar to that on the compressive strength of concrete. In the mortar tests a few waters gave somewhat higher strength-ratios and one water gave a somewhat lower strength-ratio than was obtained in concrete.

(29) The percentage of water required for normal consistency of cement when mixed with the impure waters was, with few exceptions, about the same as for fresh waters. Water from Great Salt Lake, solutions of 5 to 20% of common salt, refuse from an oil refinery, Medicine Lake water, and acid water from a spent plating bath, required somewhat higher percentages for normal consistency than fresh water.

(30) The time of setting of portland cement mixed with the impure waters was about the same as for fresh waters, however, there were some notable exceptions. In most instances the samples giving low concrete strength-ratios were slow setting. On the whole the tests show that time of setting is not a satisfactory test for suitability of a water for mixing concrete.

(31) None of the impure waters caused unsoundness of the portland cement when subjected to the standard test over boiling water.

(32) Most specifications for water for mixing concrete are so worded that they would, if strictly enforced, exclude nearly all but rain water and distilled water; these tests have shown that almost any impurity may be present without *necessarily* producing ill effects. The important point is not whether impurities are present, but do the impurities occur in *injurious* quantities?

(33) The effect of sugar and similar compounds were not studied; earlier tests have shown that these compounds are most detrimental and must be avoided.

LIST OF BOOKS ON GLASS

1. Aitken, W. C. Glass Manufacture of Birmingham and Stourbridge. Birmingham, 1851. P. 18. P. cover.

2. Ame, M. Emile. Recherches sur les Anciens Vitraux Incolores du Department de L'Yonne. Paris, 1854. P. 12. P. cover.

3. Andre, M. Auguste. De la Verrerie et des Vitraux Peints dans L'Ancienne Provence Bretange. Rennes, 1878. P. 281. P. cov.

4. Appert, L. et Henrivaux, J. Verre et Verrerie. Paris, 1894. (Encyclopedie Industrielle.) P. 460. Half cloth.

5. Arnold, Hugo and Saint, Lawrence B. Stained Glass in the Middle Ages in England and France. London, 1913. P. 268. Cloth.

6. Art of Glass Blowing. By a French Artist. London, 1831. P. 112. Cloth.

7. Baldermann, Joh. Der Practische Glashutten Techniker. Leipzig, ... P. 422. Atlas 25. Cloth.

8. Ballantine, James. A Short History of Church Stained Glass. Edinburgh, 1911. P. 16. Paper.

9. Balet, Leo. Schwabische Glasmalerei. Leipzig, 1912. P. 166. Cloth.

10. Barber, Edwin A. American Glassware. Phil., 1900. P. 112. Cloth.

11. Barber, E. A. Salt Glazed Stoneware. New York, 1907. P. 32. Boards.

12. Barrow, J. Dictionarium Polygraphicum. London, 1758. Vols. 2. L.

13. Bastenaire-Daudenart, F. L'Art de la Vitrification. Paris, 1825. P. 486. Half leather.

14. Bataile, Ed. Pour le Peinture-Vitrier. Paris, 1922. P. 163. Pa.

15. Bate, Percy. English Table Glass. New York, ... P. 130. Cloth.

16. Batissier, L. Histoire Monumental. (Chapter—Histoire de la Peinture sur Verre.) Paris, 1845. P. 633–664. Cloth.

17. Benrath, H. E. Die Glasfabrikation. Braunschweig, 1875. P. 496. Bds.

18. Berdel, Eduard. Einfaches Chemisches Practikum fur Keramiker, Glastechniker, Metalltechniker. Coburg, 1922. Theils IV.

19. Biser, Benjamin F. Elements of Glassmaking. Pittsburgh, ... P. 139. C.

20. Blancourt, H. Art of Glass. Trans. Eng. Ed. London, 1699. P. 354. C.

21. Blancourt, Handicour. De l'Art de la Verrerie. Paris, 1697. P. 371 L.

22. Blummer, H. und Von Schorn, Otto. Geschichte des Kunstgewerbes. Leipzig, 1888. P. 216. Paper.

23. Bolas, Bernard D. A Handbook of Laboratory Glass Blowing. London, 1921. P. 106. Cloth.

24. Bolas, Thomas. Glass Blowing and Working. London, 1898. P. 212. C.

25. Bontemps, G. Guide du Verrier. Traite Historique et Practique de la Fabrication des Verres, Cristeaux, Vitraux. Paris, 1868. P. 776. Paper.

26. Bontemps, G. Peinture sur Verre au XIX Siècle. Paris, 1843. P. 45. Paper.

27. Boutillier, L'Abbe. La Verrerie et les Gentilshommes Verriers de Nevers. Nevers, 1885. P. 164. Half leather.

28. Burty, Philippe. Chefs d'Oeuvre des Arts Industriels. Paris, 1866. (Section 261 to 317.) Paper.

29. Bushnell, A. J. DeHaviland. Storied Windows. Edinburgh, 1914. P. 338. Cloth.

30. Buttram, Frank. Glass Sands of Oklahoma. Norman, 1913. P. 91. P.

31. Carrick, Alice Vanleer. Collectors' Luck. Boston, 1919. P. 207. Boards.

32. Cassanova, P. Catalogue des Pieces de Verre des Epoques Byzantine et Arabe de la Collection Foquet. Memoirs, Mission Archaelogique Francais. Paris, 1913. Paper.

33. Champollion-Figeac, M. Peinture sur Verre, Mosaique, Emaux. Paris, 1851, P. 15. Boards.

34. Chance, Henry. On the Manufacture of Crown and Sheet Glass. Jour. of the Soc. of Arts, 1856. P. 11. Paper.

35. Chytil, K. and Jirik, Fr. Ausstellung von Keramischen und Glasarbeiten Bohimischen Ursprungs. Prag, 1908. P. 189. Boards.

36. Coffinnal, L. Verres et Emaux. (Encyclopedie Industrielle.) Paris, 1900. P. 332. Paper.

37. Dahmen, Walter. Gotische Glasfenster. Bonn, 1922. P. 67. Paper.

38. Danger, L. P. Die Kunst der Glasblaserei vor dem Lothrohre und der Lampe. Leipzig, 1833. P. 76. Boards.

39. Day, Lewis. Windows, A Book about Stained and Painted Glass. London, 1909. P. 420. Cloth.

40. De Fontenelle, Julia. Manuel Complet du Verrier et du Fabricant de Glaces, Cristaux, etc. (Encyclopedie-Roret.) Paris, 1829. One vol. Paper.

41. Delamardelle, Mme. la Baronne E. et Goupil, M. F. Lecons Pratiques de Peinture Vitrifiable. Paris, 1882. P. 46. Paper.

42. De Luynes, Victor. Lecon su la Trempe du Verre. Paris, 1877. P. 35.

43. De Luynes, Victor. Rapport sur la Ceramique et la Verrerie, Section Francaise Exposition Universelle de Vienne, 1873. Paris, 1875. P. 55. Paper.

44. De Luynes, Victor. Memoire sur la Trempe du Verre. Paris, 1873. P. 14. Paper.

45. Descamps, M. M. Les Vitraux de la Cathedrale de Tournai. Brussels, 1848. P. 8. Plates 12. Paper.

46. Deville, A. L'Art de la Verrerie dans l'Antiquite. Paris, 1873. Plates, 92. Boards.

47. Diaphane, Nouveau Procede Facile et Economique de Decoration du Verre. Paris, 1863. P. 40. Paper.

48. Dillon, Edward. Glass. London, 1907. P. 249. Cloth.

49. Djakonow, D. und Lermantoff, W. Die Bearbeitung des Glasses auf dem Blasetische. Berlin, 1895. P. 154. Half leather.

50. Drake, Maurice. A History of English Glass Painting. London, 1912. P. 226. Half Boards.

51. Dralle, Robert. Anlage und betriebe der Glasfabriken. Leipzig, 1886. Vol. 1, p. 490. Vol. 2, Atlas. Paper.

52. Duthie, Arthur Louis. Decorative Glass Processes. New York, 1908. P. 267. Cloth.

53. Ebert, H. Anleitung zum Glasblasen. Leipzig, 1895. P. 96. Paper.

54. Eckhardt, Ad. Verglasungen. Berlin, 1905. Plates, 30. Paper.

55. Eden, F. Sidney. Ancient Stained and Painted Glass. Cambridge, 1913. P. 160. Cloth.

56. Eisen, Gustavus A. Augustan Mosaic Glass. The Studio, January, 1923. P. 281 to 289. Paper.

57. ——————, —, —. English Church Windows. Plates, 27. Cloth.

58. Escard, Jean. La Nouvelle Industrie du Verre. Paris, 1919. P. 162. (Fabrication Electrothermique analyse des Verres, Verres de Quartz et Quartz Fondu.)

59. Faraday, Michael. Uber die Bereitung einen Glases zu optischen Gebrauch. (From the Philosophical Transactions, 1830.) P. 63.

60. Field, Kate. The Drama of Glass. Toledo, 1893. P. 48. Boards.

61. Fillon, Benjamin. L'Art de Terre chez les Potevins, suivi d'une Etude sur l'Anciennes de la Fabrication du Verre en Poitu. Niort, 1864. P. 216. Half leather.

62. Fischer, Franz. Die Kunst der Glasmalle Verarbeitung. Wein, 1892. P. 149. Paper.

63. Fischer, Josef Ludwig. Handbuch der Glasmaleri. Leipzig, 1914. P. 317. Cloth.

64. Flamm, Pierre. Le Verrier du XIX Siècle, or Enseignement Theorique de l'Art de la Vitrification. Paris, 1868. P. 511.

65. Franks, Augustos Wollaston. A Book of Ornamental Quarries. London, 1849. Plates, 112. Cloth.

66. Franks, A. W. Observations on Glass and Enamel. From "The Art Treasures of the United Kingdom." London, 1858. P. 33. Paper.

67. Frary, Francis G. Laboratory Manual of Glass Blowing. New York, 1914. P. 60. Cloth.

68. Fremy, Elphege. Histoire de la Manufacture Royale des Glaces de France au XVII et au XVIII Siecle. Paris, 1909. P. 444. Paper.

69. Gandy, Walter. The Romance of Glassmaking. London, 1898. P. 160. C.

70. Garnier, Edouard. La Verrerie et l'Emaillerie. Tours, 1886. P. 573. Cloth.

71. Gaudin, Felix. Les Vitraux des Orderes au Grande Seminaire de Besancon. Paris, 1895. P. 8. Paper.

72. Gauss, Heinr. Gefarbetes Glas in seiner Anwendung auf alle Baustyle. Weimar, 1855. P. 75. Paper.

73. Gessert, M. A. Art of Painting on Glass or Glass Staining. Eng. ed. London, 1878. P. 92.

74. Gessert, M. A. Geschichte des Glasmalerei. Stuttgart, 1839. P. 312.

75. Gerspach. L'Art de la Verrerie. Paris, 1885. P. 320. Cloth.

76. Glass Industry, The Department of Commerce. Washington, 1917. P. 430. Paper.

77. Glass. South Kensington Museum. London, ... P. 22. Paper.

78. Glasmalerei. P. 46.

79. Glass Sellers of London, The Worshipful Company of. London, 1898. P. 156. Cloth.

80. Gleichen, Alexander. The Theory of Modern Optical Instruments. Trans. by H. H. Ensley and W. Swain. London, 1921. P. 365. Cloth.

81. Goupil, M. F. Mme. la Baronne E. Delamardelle et. Lecons Practique de Peinture Vitrifiable. Paris, 1882. P. 46. Paper.

82. Grevel, Wilh. Die Steeler und Schellenberger Glashutten. Essen, 1896. P. 41. Paper.

83. Grossmann, Robert. Die technische Entwicklung der Glasindustrie in Ihrer Wirtschaflischen Bedeutung. Leipzig, 1908. P. 121. Paper.

84. Guerber, M. L'Abbe V. Essai sur les Vitraux de la Cathedrale de Strasbourg. Strasbourg, 1848. P. 124. Paper.

85. Gullick, Thomas John and John Timbs. Painting. London, 1914. P. 336. Cloth.

86. Hartshorne, Albert. Old English Glasses. London, 1897. P. 490. C.

87. Hasluck, Paul N. Glass Writing, Embossing and Fascia Work. London, 1897. P. 160. Paper.

88. Heaton, Noel. The Process of Decay in Ancient Stained Glass. 1921. Jour. of the Royal Institute of British Architects. Vol. 28, No. 18. P. 551–53. Paper.

89. Heinersdorff, Gottfried. Die Glasmalerei, ihre Technik und ihre Geschichte. Berlin, 1914. P. 155. Cloth.

90. Hebing, C. Practische Anleitung zur Ausfuhrung der Glasatzung in ihren verschiedenen Arten. Munchen, ... P. 30. Paper.

91. Henrivaux, Jules. La Verrerie au XX Siècle. Paris, 1903. P. 464. Paper.

92. Henrivaux, Jules. La Verrerie au XX Siècle. Paris, 1911, P. 679. P.

93. Henrivaux, M. J. Le Verre et le Cristal. Paris, 1897. 2 pts. P. 782. P.

94. Herman, Felix. Painting on Glass and Porcelain. London, 1897. P. 300. Cloth.

95. Hohlbaum, Rudolf. Zeitgemasse Hertstellung, Bearbeitung und Verzierung des Feineren Hohlglases. Wein, 1910. P. 255. Paper.

96. Houdoy, J. Verreries a la Fascon de Venise. Paris, 1873. P. 77.

97. Hovestadt, H. Jena Glass and its Scientific and Industrial Applications. Trans. by J. D. and Alice Everett. London, 1902. P. 419. Cloth.

98. Jaeger, Carl und Frauenberger, Georg. Kunstglaser. Munchen, 1922. P. 295. Boards.

99. James, Montague Rhodes. A Guide to the Windows of King's College Chapel, Cambridge. London, 1899. P. 38. Paper.

100. Jean, Rene. Les Arts de la Terre. Paris, 1911. P. 480. Paper.

101. Kampmann, C. Die Dekorirung des Flaschglases durch Atzen und Anwendung chemigraphischer Reproductionsarten fur diesen Zweck. Halle, 1889. P. 141. Boards.

102. Kisa, Anton. Das Glas in Altertume. Leipzig, 1908. P. 900. C.

103. Kunckle, Neri, et Merret. Art de la Verrerie. Paris, 1752. P. 620. Boards.

104. Lane-Poole, Stanley. Arabic Glass Weights. London, 1891. P. 127. Paper.

105. Langlois, E. H. Essai Historique et Descriptif sur la Peinture sur Verre, Ancienne et Moderne. Rouen, 1832. P. 301. Boards.

106. Leonard, William. The Arts and Crafts of Old Spain. London, 1907. Vol. 2, p. 223 to 263. Cloth.

107. Leng, Heinrich. Handbuch der Glasfabrication. Weimar, 1854. P. 740. Boards.

108. Leroy, F. N. Essai sur les Vitraux de Blosseville-es-Plains. Paris, 1860. P. 127. Paper.

109. Lethaby, W. R. Stained Glass Work. New York, 1905. P. 381. Bds.

110. Le Vaillant de la Fieffe, O. Les Verreries de la Normandie. Rouen, 1873. P. 552. Paper.

111. Lewis, J. Sidney. Old Glass and How to Collect It. London, ... P. 225. Boards.

112. Lobmeyer, L. Die Glasindustrie, ihre geschichte, gegenwartige entwicklung und Statistik. Stuttgart, 1874. P. 321. Paper.

113. Lonsel, Burger. Versuch einer ausfurlichen Anleitung zur Glasmacherkunst fur Glashuttenbesitzer und Sameralisten mit Ructicht auf die neuern Grundsatze der Chemie. Frankfort, 1802. P. 540. Boards.

114. Magne, Lucien. L'Art applique aux Metiers. Paris, 1913. P. 220. Cloth.

115. Magne, Lucien. Decour du Verre, Gobeleterie, Moszique, Vitral. Paris, 1913. P. 220. Paper.

116. Magne, M. Lucien. Les Vitraux de Montmorency et d'Ecouen. Paris, 1888. P. 68. Paper.

116*a*. Malpeyre, F. et Julia De Fontenelle. (Encyclopedie Roret.) Noveau Manuel Complet du Verrier et du Fabricant de Glaces, Cristaux, etc. Paris, 1854. Vols. 3. Paper.

117. Marchis, M. L. Les Modifications Permanents du Verre et le Deplacement du Zero des Thermometres. Bordeaux, 1898. P. 442. Paper.

118. Marson, Percival. Glass and Glass Manufacture. London, 1920. P. 127. Cloth.

119. Merson, Oliver. Les Vitraux. Paris, 1895. P. 315. Paper.

120. Miller, J. B. Die Verzierung der Glaser dur den Sandstrahl und die Sandblasmachinen. Wien, 1911. P. 146. Paper.

121. Morin, Jean. La Verrerie en Gaule sous l'Empire Romain. Paris, 1913. P. 306. Paper.

122. Muspratt, S. Glass Chemistry as Applied to Arts and Manufacture....... P. 183 to 250.

123. Nelson, Philip. Ancient Painted Glass in England. London, 1913. P. 280. Cloth.

124. Neri, Ant. L'Arte Vetarri Distincta in Libri VII. Florence, 1612. P. 114. Vellum.

125. Nesbitt, Alexander. Notes on the History of Glass Making. (Prepared as an Introduction to the Catalogue of the Slade Collection.) London, 1869. P. 59. Cloth.

126. Nesbitt, Alexander. Glass. London, 1878. P. 43. Cloth.

127. Oidtmann, Heinrich. Geschichte der Schweizer Glasmalerei. Leipzig, 1905. P. 303. Cloth.

128. Painted Glass, An Introduction to the Study of. (A. A.) London, 1898. P. 80. Cloth.

129. Pazaurek, Gustav E. Moderne Glaser. Leipzig, ... P. 134. Boards.

130. Peinture sur verre sur Porcelaine et sur Email. (Encyclopedie Roret.) Paris, 1913. P. 602. Paper.

131. Peligot, Eug. La Verre, Son Histoire, Sa Fabrication. Paris, 1877. P. 495. Half leather.

131*a*. Pelletier, Pierre. Les Verriers dans le Lyonnas et le Forez. Paris, 1887. P. 288. Paper.

132. Perceval, Maciver. The Glass Collector. New York, 1919. P. 330. Cl.

133. Perdrizet, Paul. Verres de Sidon. 1906. P. 291 to 300.

134. Pettke, Charles Reinhard. Glass Manufacture and the Glass Sand Industry of Pennsylvania. Harrisburg, 1919. P. 278. Paper.

135. Poller, Heinr. Anton. Die Kunst all Arten von Zeichnungen als Blumen Thiere, Landschaften, Portraits in Glas zu atzen. Leipzig, 1833. P. 15. Boards.

136. Porcelain and Glass. London, 1852. P. 334. Half leather.

137. Powell, H. J., Chance, Henry and Harris, H. G. The Principles of Glass Making. London, 1883. P. 186.

138. Powell, H. J. Glass-making in England. 1923, Cambridge. P. 383. Cloth.

139. Randau, Paul. Die farbingen bunten und verzierten Glaser. Wien, 1905. P. 347. Paper.

140. Ree, Paul Johannes. Das Glas in Kunstgewerbe. Munchen, 1904. P. 18. Paper.

141. Renner, Franz C. und Seeman, Max. Moderne Ideen dur rie Kunstglaserei. Wein, ... 18 Sheets of drawings.

142. Richardson, Charles Henry. Glass Sands of Kentucky. Frankfort, 1920. P. 149. Cloth.

143. Sambon, Arthur. Les Verres Antiques. Paris, ... P. 52. Paper.

144. Sauzay, A. Marvels of Glass Making in All Ages. London, 1870. P. 272. Cloth.

145. Sauzay, A. La Verrerie Depuis les Temps les plus Recules Jusque Nos Jours. Paris, 1876. P. 311. Paper.

146. Schmoranz, Gustav. Old Oriental Gilt and Enamelled Glass Vessels. Vienna, 1899. Plates 32. Board covers.

147. Schipmann, W. Aus der Praxis Eines Glashuttenfachannes. Hannover, 1907. Two parts, p. 75. O. 97. Paper.

148. Schmidt, Chris. Heinr. Die Fabrikation der fur die Glasmalerei Emailmalerei und Porzellanmalerei geeigneten Farben. Weimar, 1861. P. 282. Paper.

149. Schmidt, Robert. Die Glaser der Sammlung Muhsam. Berlin, 1914, p. 79. Plates 36. Boards.

150. Schmitz, Hermann. Deutsche Glasmalereinen der Gotik und Renaissance. Munchen, 1923. P. 102. Boards.

151. Schnurpfeil, P. K. Ed. Die Glasfabrikation in ihren ganzen Umfange, unter besonderer Berucksichtigung der Haupt und Nebenofen. Leipzig, 1923. P. 182. Paper.

152. Schnurpfeil, Hans. Die Glasschmelzofen und ihre Feuerunglanlage lagen. Dresden, 1911. P. 128. Boards.

153. Schnurpfeil, Paul. Das Glas in seiner verschiedenen Farbentechnik. Strassburg, 1911. P. 75. Paper.

154. School of Wisdom. London, 1776. Just a brief chapter. Leather.

155. Schreiber, Emanuel. Die Glasblasenkunst sowohl auf der Glashutte. als an der Glasblaserlampe. Weimar, 1849. P. 224. Boards.

156. Schreiner, E. E. Scientific Tests for Colored Glass for Optical Purposes. New York, 1919. P. 84. Cloth.

157. Schur, Otto. Die Praxis der Hohlglas-Fabrikation. Berlin, 1867. P. 140. Boards.

158. Secrets in Arts and Trades. London, ... P. 68 to 97. Leather.

159. Sharpe, Edmund. Decorated Windows. London, 1849. Vols. 2. Cloth.

160. Shaw, George W. On the Manufacture of Glass. Birmingham, 1852. P. 14. Paper.

161. Shenstone, W. A. The Methods of Glass Blowing. London, 1918. P. 98. Cloth.

162. Sherrill, Charles H. Stained Glass Tours in France. London, 1922. P. 298. Cloth.

163. Sherrill, Charles H. A Stained Glass Tour in Italy. New York, 1913. P. 175. Cloth.

164. Sherrill, Charles H. A Stained Glass Tour in England. New York, 1910. P. 254. Cloth.

165. Simon, Paul. La Grande Rose de la Cathedrale de Reims. Reims, 1911. P. 87. Paper.

166. Singer, Ing. Felix. Uber den Einflus von Tonerde auf die Schmelzbarkeit von Glasern. Berlin, 1917. P. 34. Paper.

167. Springer, Ludwig. Laboratoriumsbuch fur die Glasindustrie. Halle, 1919. P. 143. Paper.

168. Springer, Ludwig. Das Glas. Halle, 1922. P. 104. Boards.

169. Spohn's Encyclopedia of Manufactures (Glass P. 1043–1087. by J. H. P.) London, 1882. 2 Vols. Cloth.

170. Stahl, C. J. Glaserkunst, Glasmalerei und moderne Kunstverglasung. Wein, 1912. P. 240. Paper.

171. Stannus, Graydon. Old Irish Glass. London, 1921. Plates, 60.

172. Stein, M. Die Glasfabrikation. Braunschweig, 1862. P. 142. Bds.

173. Strehblow, Heinrich. Der Schmuck des Glases. Leipzig, 1920. P. 174. Boards.

174. Suffling, Ernest R. Treatise on the Art of Glass Painting. London, 1902. P. 139.

175. Thibaud, Emile. Considerations Historique et Critique sur la Peinture sur Verre. Paris, 1842. P. 127. Half leather.

176. Tiffany Fabrile Glass. Tiffany Glass and Decorating Co. New York, 1896. Leather.

177. Ulig, Edward C. Chemical Analysis for Glassmakers. Pittsburg, 1903. P. 136. Cloth.

178. Van Rensselaer, Stephen. Early American Bottles and Flasks. New York, 1921. P. 110. Cloth.

179. Vigreux, Henri. Le Soufflage du Verre. Paris, 1920. P. 268.

180. Von Schorn, Otto, Blummer, H. und. Geschichte des Kunstgewerben. Leipzig, 1888. P. 216. Paper.

181. Wackernagle, Wilhelm. Die Deutsche Glasmalerei. Leipzig, 1855. P. 180. Paper.

182. Wallace-Dunlop, M. A. Glass in the Old World. London, ... P. 272. Cloth.

183. Warring, J. B. Glass and Enamel. London, ... P. 17. Cloth.

184. Warring, J. B. Masterpieces of Industrial Art and Sculpture at the International Exposition, 1863. London, 1863. Three vols., many plates. Leather.

185. Weale, John. Works of Early Masters in Stained Glass. London, 1841. Two vols. of plates.

186. Werck, Alfred. Stained Glass. New York, 1922. P. 167. Cloth.

187. Westphale, Louis. Vitraux Composes et Dessins. 2 Folios. 34 plates. Boards.

188. Westrop, M. S. Dudley. Irish Glass. London, 1921. P. 206. Cloth.

189. Weyl, Th. Einzelschriften zur Chemischen Technologie. Leipzig, 1911. P. 103. Paper.

190. Whall, C. W. Stained Glass Work. London, 1920. P. 381. Cloth.

191. Whittock, Nathaniel. The Decorative Painter's and Glazier's Guide. London, 1827. P. 332. Leather.

192. Williams, Lenore Wheeler. Sandwich Glass. Bridgeport. 1922. P. 102. Cloth.

193. Williams, Leonard. Arts and Crafts of Old Spain. London, 1907. Vols. 3. Cloth.

194. Wilmer, D. Early English Glass. London, ... P. 282.

195. Winston, Charles. Hints on Glass Painting. London, 1867. Vols. 2. Cloth.

196. Woollatt, G. H. Laboratory Arts (Glass Making). London, 1918. P. 180. Cloth.

197. Woytacek, Carl. Lehrbuch der Glasblaserei. Hamburg, 1924. P. 279. Cloth.

198. Wright, F. E. Manufacture of Optical Glass and Optical Systems. Washington, 1921. P. 309. Cloth.

199. Yoxall, J. H. Collecting Old Glass, English and Irish. New York, 1914. P. 109.

200. Zschimmer, Eberhard. Die Glasindustrie in Jena. Jena, 1909. P. 160. Paper.

201. Zschimmer, Eberhard. Chemiebuchlein des Glasschmelzers. Jena, 1923. P. 86. Paper.

202. Becket, T. Etruscan Vases. London, 1806. P. 99. Cloth.
203. Appert, A. et. J. Henrivaux. La Verrerie depuis vingt ans. Paris, 1894. P. 148. Paper.
204. Oeuvres de M. D'Antic. Paris, 1790. P. 321. L.

"SCIENCE IN INDUSTRY," RADIO PUBLICATION ISSUED

The University of Pittsburgh has recently issued a pamphlet entitled "Science in Industry" consisting of a series of seven radio talks which were delivered during the winter. Among those who participated in these addresses for the radio were E. Ward Tillotson, Assistant Director, Mellon Institute and President of the AMERICAN CERAMIC SOCIETY, whose subject was "Glass" and MacDonald C. Booze, Senior Industrial Fellow and member of the SOCIETY who talked on "Clay Products." The other addresses in the pamphlet are "Science in Industry" by Edward R. Weidlein, Director of Mellon Institute; "Iron and Steel" by Stephen L. Goodale, Professor of Metallurgy; "Natural Gas" by James B. Garner, Senior Industrial Fellow, Mellon Institute; "Petroleum" by Warren Fred Faraghen, Head of Dept. of Petroleum Refinery Technology, School of Mines; "Coal and Coke" by Frederick W. Speer, Jr., Advisory Fellow, Mellon Institute.

A Select Bibliography is appended to each address and William A. Hamor, Assistant Director of Mellon Institute writes the Introduction. Copies of this publication may be obtained for 60 cents per copy.

CALENDAR OF CONVENTIONS

Organization	Date	Place
Am. Assn. Advancement of Science	Dec. 28–Jan. 2	Kansas City, Mo.
Am. Assn. of Flint and Lime Glass Mfrs.	July, 1925	Atlantic City, N. J.
AMERICAN CERAMIC SOCIETY		
(Annual Meeting)	Feb. 8–13, 1926	Atlanta, Ga.
(Summer Meeting)	July 4–11, 1925	Toronto, Canada
(Fall Meeting)	Oct. 1, 1925	New York City
Am. Electrochemical Soc.	Sept. 24–26, 1925	Chattanooga, Tenn.
Am. Engineering Council	Jan., 1926	
Am. Foundrymen's Assn.	Oct. 5–9, 1925	Syracuse, N. Y.
Am. Gas Assn.	Oct. 12–16, 1925	Atlantic City, N. J.
Am. Inst. of Chem. Engrs.	June 22–25, 1925	Providence, R. I.
	July 13–16, 1925	Leeds, England
Am. Inst. of Min. and Met. Engrs.	Aug. 31–Sept. 5, 1925	Salt Lake City, Utah
Am. Iron and Steel Inst.	May 22, 1925	New York, N. Y.
Am. Mining Congress	May 25–29, 1925	Cincinnati, O.
Am. Soc. of Mechanical Engrs.		
(Spring Meeting)	May 18–21, 1925	Milwaukee, Wis.
(Annual Meeting)	Nov. 30–Dec. 3,	New York City
(Pacific Coast Regional Meeting)	June 22–25, 1925	Portland, Ore.
Am. Soc. for Testing Materials	June 22–26, 1925	Atlantic City, N. J.
Am. Zinc Institute	April 27–28, 1925	St. Louis, Mo.
Assn. Iron and Steel Elec. Engrs.	Sept., 1925	Philadelphia, Pa.
Chemical Equipment Exposition	June 22–27, 1925	Providence, R. I.

Organization	Date	Place
Common Brick Manufacturers Assn.	Feb., 1926	
Glass Container Assn.	April 30–May 2	Atlantic City, N. J.
Institution of Chemical Engineers	July 13–16, 1925	Leeds, England
Manufacturing Chemists' Assn.	June, 1925	New York City
Mining and Met. Society of America	Jan. 12, 1926	New York City
Natl. Assn. of Mfrs.	Oct. 26–28, 1925	St. Louis, Mo.
Natl. Assn. of Stove Mfrs.	May 13–14, 1925	New York City
Natl. Chemical Equipment Assn.	June 22–27, 1925	Providence, R. I.
Natl. Exposition of Power and Mechanical Engrs.	Nov. 30–Dec. 5	New York City
Natl. Lime Assn.	May 26–29, 1925	Briarcliff Manor, N. Y.
Natl. Exposition of Chem. Industries	Sept. 28–Oct. 3	New York City
Natl. Ornamental Glass Mfrs. Assn.	June 4, 1925	Pittsburgh, Pa.
Natl. Paving Brick Mfrs. Assn.	Jan., 1926	
Natl. Safety Council	Sept. 28–Oct. 2	Cleveland, O.
Natural Gas Assn.	May 18–21, 1925	Atlantic City, N. J.
New Jersey Clay Workers Assn.	June, 1925	Trenton, N. J.
Sand-Lime Brick Assn.	Feb., 1926	New Orleans, La.
Sheet Metal Ware Assn.	June, 1925	Cincinnati, O.
Soc. of Chem. Industry	July 13–16, 1925	Leeds, England
Taylor Society	May 14–16, 1925	Ann Arbor, Mich.

BULLETIN

of the

American Ceramic Society

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

Vol. 4 — June, 1925 — No. 6

EDITORIALS

PROFESSIONAL CERAMICS

Ceramics is being more generally recognized as a profession. More universities are considering giving courses in ceramics to train men for industrial service.

Professional ceramics is the using of science in the making of marketable wares of specified character and quality. A ceramist is one who has the knowledge, vision and art required to produce ceramic wares. His capability to meet the ever changing trade conditions, tastes and specifications is in direct ratio with his ceramic knowledge, vision and skill.

Obviously the making of each kind of ceramic ware calls for a peculiar combination of facts, direction of vision and construction skill. With the same fundamental training and information each ceramist will use special knowledge of materials and processes according to the kind of ware produced. Continued employment in the production of one type of ceramic ware very soon makes him a specialist, that is, he is better informed and is more skilled in the making of a certain type of ceramic ware although employing the same facts and concepts used in all lines of ceramic manufacturing.

It remains as a truism, however, that the more thoroughly trained the professional ceramist is in finding and using science fundamentals, the more largely developed his ability to vision service or trade requirements and

the more skilful is he in fabrication, the broader at all times will be his industrial capacity to produce and the more effective will he be as a specialist.

Since chemistry, physics and mathematics deal with the fundamental facts and relations of all matter and materials used by ceramists, as by all industrial scientists, these are the foundation of our ceramic science. The more thoroughly trained in these the larger will be the capacity and vision of the professional ceramist. A university course of ceramic instruction should provide a thorough training in chemistry, physics and mathematics. A high school course should have enough training in these fundamentals to acquaint the pupil with the more basic facts and laws but especially to give a vision of the relations of matter and materials used in ceramic ware and ceramic processing. These sciences are fundamental to engineering and art. Engineering is more particularly and almost wholly the using of these science fundamentals in the devising of means and methods of fabricating marketable wares. Art deals with form and decoration but employing ceramic materials compounded and prepared. These same fundamental sciences (chemistry, physics and mathematics) are essential to the ceramic artist who is to attain the greatest possible breadth of vision and capacity to accomplish.

If professional ceramics is based so almost wholly on the fundamental sciences it is natural to ask why should the universities give special courses in ceramic science, engineering and art? The answer is found in the need of focusing on the fundamental facts concerning the materials and processes used in production of ceramic wares of specific kind and quality. Ceramics uses a limited lot of raw materials. Its processes of fabrication are peculiar. It is a specialty of definite limitations yet so broad and with such complexes as to exceed capacity of an individual to survey and know completely.

University courses of instruction are for the purpose of specializing in the application of science fundamentals to the employment of a limited variety of raw materials in the production of silicate ware of definite sorts.

Professional ceramics has gone a long way in the finding and applying of fundamental facts regarding ceramic materials and processes. To this the university instruction has until now been almost wholly devoted. We know a great deal about the industrial possibilities of ceramic materials and mixtures and a great deal of the engineering employed in ceramic processing. Our universities have been wise in concentrating on this particular phase of professional ceramic training for there was much and there is yet much to discover about materials and processes. There has been a great need for this knowledge and there is yet a great deal to be learned. But certainly the equipment of a professional ceramist would not be in

balance if he has not been trained to vision, to measure and to produce wares for definite purposes. And for too long a while has the professional preparation of a ceramist neglected the need of form, color and design. We are in need of ceramists of vision, one who can anticipate service and market demands. Our universities have not been giving this most needed training.

How long will American ceramists have to be trailing in the production of ceramic products of specific quality? Is not the answer until our ceramic technologists are trained to vision, produce and to measure product properties? Does not the situation warrant redesigning of the collegiate courses so as to stress product rather than materials? Should not the fundamental science facts, concepts and methods be used in studying products as they are now being employed in studying materials and mixtures.

Our plea is for professional ceramists trained to vision ceramic products and with knowledge of how to produce to specifications.

CERAMIC EDUCATION PROGRAM

One of the chief purposes of the AMERICAN CERAMIC SOCIETY is to promote ceramic education. The number of ceramic schools and their territorial distribution need not be considered. The justification for ceramic schools in various localities is based on local needs and hence is a local rather than general or national interest. Whether there are a sufficient number of ceramic schools or too many, and whether all localities are being adequately served are questions having little or no place in the general question "what this SOCIETY should promote."

All promotional activities of this SOCIETY are given direction by the most urgent industrial needs. The purpose of the SOCIETY'S promotional activities in ceramic education is to obtain a consideration by thoughtful people of how ceramic schools may render the most needed and timely service to the ceramic industries, and how the industries can collaborate with the schools. There is no possible criticism of the intent of the directors of the ceramic schools. They aim that their schools shall serve effectively.

The importance of ceramic education has prompted the Committee on Education to arrange a symposium for the 1926 Annual Meeting at Atlanta. The first general session will be devoted to it. A round robin mail discussion is to be conducted in anticipation so the facts will be better known. Mature judgment is wanted and this will be possible only after the manufacturers and the school instructors have developed the facts. This subject is worthy of a hearty and thoughtful participation by all members of the SOCIETY in this important conference.

PROFIT IN MEETINGS

In July this SOCIETY will have a summer excursion meeting in Canada and will hold the Annual Meeting in Georgia next February. These meetings are for definite purposes. If the value received did not warrant the time and expense of attending they would not be so largely attended.

The purposes of these meetings are many but in general they are to promote ceramic research and education. The more each learns, the broader our knowledge and acquaintance, the greater facility we have to acquire and to accomplish. With the increasing numbers of those who know from experience and experiments there is an increasing opportunity in these meetings to obtain at first hand records of things proven and an appreciation of things yet to be done. A week at one of these meetings is worth in information and inspiration more than months in the shop or laboratory. These meetings are the most effective means of promoting research and education because they are intensively personal.

The men who participate in the programs and in the clubby informals have entered ceramics with a widely varied preparation. All of them are thinkers naturally and many have had years of manufacturing experience. Several have thought and studied their way through the "school of hard knocks" always focusing on their customers' ideals. They want explanations of the facts as they know them. A vast amount of the recorded ceramic knowledge has been initiated by recitals of the experiences and findings of the pupils from the school of hard knocks.

There are several who have entered the ceramic industries as chemists, physicists and engineers. They have had a broad fundamental training and always have unorthodox viewpoints. Contact with these men stimulates thought and enlarges vision. They have well trained minds and a fund of knowledge sufficiently dissimilar to be very inspiring when dealing with ceramic problems.

Technologists, engineers and artists from all sorts of ceramic industries convene at these meetings. One need take no more than a cursory inventory of the new ideas recently applied but originating from a wholly dissimilar industry to realize the value there is in exchanging ideas and recitals of experiences with men engaged in the different ceramic industries. The foundry and the clay shop continue to reciprocate in new processes, devices and control methods.

The managers, salesmen, engineers, miners, scientists and teachers complete the facility to obtain a refreshing vision of what must be done to increase sales. This combination will head all considerations in terms of product. The school instructors and the bureau investigators have been investigating product from the science viewpoint and by scientific methods. They have concentrated either on quality of product or economy

in production. They depend on these meetings to obtain the sales viewpoint so necessary in research. They have basic facts regarding the product which the salesman must have if he is to most effectively present his wares and most intelligently bring to the factory the new demands.

A week spent at one of these meetings is of more value than several weeks in the shop or laboratory. The broadening opportunities at these meetings would require many weeks and miles of traveling to equal. It pays to attend the meetings of the AMERICAN CERAMIC SOCIETY.

PAPERS AND DISCUSSIONS

SAVING FUEL IN FIRING COMMON BRICK[1]

By W. D. Richardson

ABSTRACT

Requirements of economy and fuel conservation, and incidentally the elimination of the smoke nuisance, make it necessary for America to follow the lead of Europe in adopting the regenerative continuous kiln of some kind for the burning of all clay products. For common brick the most practical and economical kiln is the annular kiln, a modification of the original Hoffman "Ringofen."

With simple automatic stokers and induced draft there is more rapid advance of the burning of the annular kiln and a greater saving of fuel. The compartment kiln and the tunnel kiln is unnecessarily expensive in installation and upkeep for low-priced product. Basis of different forms of the annular kiln is given.

The waste of fuel and the pollution of the atmosphere with smoke in the brick industry are notorious. The reasons for confining this subject to the firing of common brick are:

(1) The manufacture of common brick is the largest and the most essential part of the structural clay product industry, which includes also face brick, hollow building tile, roofing tile, terra cotta, drain tile and sewer pipe.

(2) Common brick is the cheapest clay product, and is sold for the lowest price per ton, not only of any clay product, but of any finished structural product.

(3) Because of the low price of common brick, the means of saving fuel in the firing of them, the fuel-saving kilns, must be quite different from what would be practical in other branches of the brick industry; they must not cost so much to construct that the interest on the increased investment, together with the up-keep, will amount to more than the saving of fuel, and thus add to the price at which the brick must be sold. "The economic and business world knows no waste, unless the saving can be accomplished at a profit."[2]

The means of saving fuel, however, in the firing of common brick are the same as that of any other clay product, as well as that in any ceramic or metallurgical operation, namely, regeneration and recuperation. The principle of regeneration was first applied to the firing of brick in Germany more than 60 years ago, the first practical kiln having been invented by Friedrich Hoffman in 1858. The Hoffman kiln, or some modification of it, has become almost universal in Europe and its use has spread all over the world. That it is not generally used in the United States is due chiefly to the wastefulness of America, which is proverbial, and to the fact that

[1] Presented at the Annual Meeting, American Ceramic Society, Columbus, Ohio, February, 1925. (Heavy Clay Products Division.)

[2] "The Relativity of Waste," by Alfred Pierce Dennis.

in this country fuel has been abundant and cheap and labor high, so that our attention has been given to means of saving labor rather than saving fuel.

Another thing that has retarded the adoption of the continuous kiln in this country is that until recently the kilns of this character that have been built here have, for the most part, not been adapted to our conditions, having been imported or designed not by engineers or technical men, but by men who have perhaps worked on some plant in Europe and who have not understood some important feature or who, building a fairly good kiln, did not know how to operate it.

Conditions Have Changed

While labor is high, fuel has been much increased in price and, moreover, the Government, realizing that coal and oil are resources that are limited and are not now being formed, have inaugurated a policy of conservation, and we are all beginning to realize that it is our duty not to waste fuel.

The fully regenerative kiln is necessarily continuous in operation. Brick must be constantly firing, so that the hot gases passing through that part of the kiln under fire can be drawn through unfired brick, preheating them before escaping to stack; also so that there may always be burned brick back of the fire that, in cooling, heat the air for the combustion of the fuel. Hence, these kilns are generally known in this country as continuous kilns, the operations of setting, drawing and firing going on continuously in the same kiln. The original form of such a kiln was an annular tunnel in a round structure, with stack in the center, hence this kiln in Germany was called a "Ringofen." Continuous kilns are now generally oblong, the annular tunnel becoming two parallel tunnels connected at both ends, the ends being square, or a continuous tunnel, the ends being round, the smoke flue in both cases being between the two parallel tunnels. The tunnel is divided into chambers of a convenient size by means of paper partitions, to prevent back draft, there being a door in the outer wall at the end of each chamber through which the dried brick are taken for setting and the burned brick in drawing.

In another form of the continuous, progressing-fire tunnel kiln the parallel firing tunnels are separated by an open space that is utilized for taking the brick into the kiln, the outer side of tunnels having doors for taking out the burned brick. In some cases in this country there is only a single tunnel in a straight line. Such a kiln is not fully regenerative, since when it has been fired down the line to the end of the tunnel, the combustion gases must be wasted, as the distance is generally too great to utilize them for preheating the other end of the kiln, which must hence have starting furnaces, using cold air for combustion.

Another form of the continuous kiln is a series of parallel down-draft kilns in juxtaposition, the crowns resting on the partition walls between the

kilns. This is generally known as the compartment kiln. The progressing fire tunnel kiln may be divided into separate compartments also by permanent brick partitions, which form we designate a tandem-compartment kiln.

We must include also in the class of continuous kilns a form that is now being vigorously promoted, the railroad or car tunnel kiln, a long narrow tunnel with a track on which cars loaded with the products to be fired are mechanically and continuously or intermittently pushed through the tunnel from end to end, the fires being stationary and every cross-section of the kiln being kept constantly at a fixed temperature.

The problem then in the common brick industry is, which form of the continuous regenerative kiln is best for this low-priced product, since the only practical way of saving any great amount of fuel in the firing of common brick must be in making application of the regenerative principle of the continuous kiln.

The car tunnel kiln, properly constructed and operated, is undoubtedly the most economical in fuel, but it costs too much for installation and upkeep to be practical for common brick. Moreover, with clays that require time for oxidation, the car tunnel kiln must be operated on too slow a schedule, with too small an output. Also, for clays that have a high or sudden fire shrinkage most tunnel kilns are likely to give serious trouble from the brick on the outer courses of the car pulling over and rubbing against the sides of the tunnel or falling off and blocking the movement of the cars. Those who are promoting the tunnel kiln may argue otherwise, and with some reason. It would take too much time to discuss the question in this paper, so I shall dismiss it with the brief statement of my opinion that while the tunnel kiln will burn common brick, even better than in the present periodic kilns, yet another form of the continuous kiln, costing about half as much and saving nearly as much fuel, is more practical. It is not sufficient to get something better, but we must have the best, the most practical, the most economical kiln for every product.

The compartment continuous kiln can be adapted to the firing of any clay product, but it also involves too large an investment for the common brick manufacturer. An exception to this statement, with clays that will stand fairly rapid drying, so that the kiln-drying system can be used, is the open-top compartment kiln, fired with producer gas. The portable crown with cast iron frame is too costly. A simpler covering for the top is practical, making this kiln, with the automatic conveyors, one of the most economical systems of common brick manufacture. Such a system, as well as any continuous kiln system, should be designed and installed by an engineer of experience in this line.

The original form of continuous kiln, the progressing-fire tunnel kiln, known the world over as the Hoffman kiln, is the cheapest, simplest and

most practical kiln for the firing of common brick. The saving of fuel in this kiln is greater than in the compartment kiln and is almost as great as in the car tunnel kiln, and in some cases fully as great. There are many modifications of the Hoffman kiln, based on features described here.

Method of Taking Combustion Gases from the Kiln

In one form of the Hoffman kiln the products of combustion are taken from the bottom of the tunnel, on one or both sides of the chamber, the outlets into the bottom of the smoke flue between the parallel tunnels being regulated by dampers operated on top of the smoke flue. In another form the products of combustion are taken out of the top of the tunnel in each successive chamber and conducted into the top of the smoke flue by portable pipes or sheet iron breechings.

There has been much discussion in conventions of brick manufacturers in Germany and in German journals of the clay industries as to which method of removing the combustion gases gives the better results. From these discussions by engineers and manufacturers I gather that both methods, when the kilns are properly designed for each and properly operated, are successful. In our own design of this kiln we have adopted the uptake method of removing smoke and combustion gases.

Method of Watersmoking

There are many modifications of the Hoffman kiln based on different methods of watersmoking. It was early discovered that the original Hoffman kiln, watersmoked with the combustion gases after passing through four or five chambers of brick being preheated, produced scumming or discolorations. This objection to the new Ringofen was at first quite serious. It was investigated by Dr. Seger, who found that the gases from the coal and from the clay coming in contact with the cold, freshly set brick condensed on the brick, the water and sulphurous gases forming sulphuric acid which combined with the alkalis and alkaline earths of the clay and produced a scum on the surface of the brick, or discolored the edges. His diagnosis was accepted and his recommendation for preventing this has been in use ever since, namely the warming up of the freshly set chambers with air heated by cooling chambers. There are several patented features based on different methods of doing this.

A special watersmoking flue is generally constructed over the smoke flue, the damper rods of the draft valves extending up through this flue. Iron pipes or breechings connect the cooling chamber with the watersmoking flue and other iron pipes connect this flue with the chamber to be watersmoked, the heated air being drawn into the chamber by the natural or mechanical draft of the kiln through the regular draft valve. The

different methods of accomplishing this watersmoking are for the purpose of getting a better distribution of the heat throughout the chamber. In no case is this perfect. Arrangements for better distribution are sometimes too complicated and costly to be practical. Perfection is not necessary, since completion of the watersmoking is not required to prevent discoloration of the brick, only the heating up of the chamber to a temperature high enough, about 150°F, to prevent condensation of the combustion gases.

In the Hoffman kiln with the up-take of combustion gases, the watersmoking or preliminary heating has been done by pulling outside air through one or more freshly set chambers the air being warmed by the heat stored in the kiln walls. In our form of top outlet there is a watersmoking flue underneath the smoke flue, and the heated air from the cooling chambers is pulled up through the chamber to be watersmoked.

Method of Setting

The setting of the Hoffman kiln must be done right to get the best results. The manner of setting with different kinds of ware has been well worked out. It is not within the province of this paper to give instructions on this.

Method of Firing

The Hoffman kiln is fired through small openings in the crown, the holes extending up through the filling and paving, with a cast iron frame in the top and a cast iron cover. The firing holes are properly spaced from long experience and a certain number of rows of holes are always being fired. Coal is not fired into a hole until the brick underneath are hot enough to burn the coal readily. The old method of firing such a kiln is with a small fire shovel such as is used in house-heating stoves. This method would be fairly efficient, if only a small amount of coal were put in at a time and the firing done often enough, except that too much heat might be lost by opening up the top too frequently, but this is practically unattainable, especially at night. The modern method is automatic firing with a practically steady stream of fine coal, only as much being fed as will be immediately consumed from top to bottom of kiln. This method gives more uniform burning and with less coal, estimated by German engineers at 20 to 30% less.

Dimensions of Kiln

There are now well-established rules for proportioning the dimensions of the firing tunnel, draft outlets, main draft flue, stack, etc. In building a kiln today the engineer need not guess, but can calculate every dimension quite accurately.

Draft

The Hoffman kiln, like all other continuous kilns, requires a strong draft for successful operation. It has been a most common mistake in the building of continuous kilns in America that the stacks have not had power enough and the firing has been too slow. This has now been remedied by the use of induced draft fans instead of stacks. With induced draft, moreover, the greater utilization of the heat of the combustion gases generally pays for the operation of the fan, and by the stronger and more constant and uniform draft the firing advance is more rapid. This more rapid advance of the fires also gives more heat from the cooling chambers for drying the brick.

Drying Brick from Waste Heat of the Hoffman Kiln

There has been much discussion on the practicability of drying brick with the heat of the cooling chambers of a Hoffman kiln, some arguing that the only waste heat available is what can be utilized in drying racks over the kiln, an almost universal practice in Europe for many years. In recent years, however, with the more rapid firing with induced draft, heat is being drawn to tunnel driers on the yard level. There has always been more heat in the cooling compartments than is needed for heating the air for combustion, but with slow firing this was not available for use in drying in tunnel driers, since the pull of the waste heat fan interfered with the draft of the kiln or drew combustion gases into the drier, but with more rapid advance of the fires, the heat for drying is drawn back of open doors or so far from the fires as not to interfere with firing operations. Of course, there is not so much waste heat from continuous kilns as from periodic kilns, but it is entirely practical to get a portion of the heat for drying from this source, the amount depending upon the special form of continuous kiln and the rapidity of the firing.

Fuel Consumption of the Hoffman Type of Kiln

There are many published records of fuel consumption in the Hoffman kilns in Europe. Where these reports are given in weight of coal per thousand brick, they are not of much use to us, unless we know the weight of the larger size brick made there and something of the thermal value of the coal, but where the results are given in per cent of the weight of the coal to the weight of the brick and the finishing temperature or cone is given, as is generally the case, we can get a fairly accurate knowledge of the economy of the kiln. Accurate, understandable records of fuel consumption in the Hoffman kilns in this country are scarce, as they are also in all types of kilns. I have recently had the privilege of seeing a number of Hoffman kilns in Nebraska and Missouri, firing common brick, face brick and hollow building tile, all hard, well-fired ware, at a low fuel cost,

unquestionably about one-third of what the consumption would be in periodic kilns. I also saw a Hoffman kiln at Salt Lake City which was turning out good common brick at a reported consumption of about 225 lbs. per thousand. The fuel consumption in these kilns could be lowered by automatic feeding of the coal and by pulling the combustion gases farther ahead of the fire by a stronger draft.

Other Advantages of the Continuous Kiln

An advantage of the continuous kiln is that the plant is most compact, occupies the least ground space, is all under cover and can be operated in all kinds of weather. In other words it is a brickmaking factory, instead of a brickyard.

With automatic coal unloaders and conveyors and automatic stoking the labor of firing is reduced to the minimum.

Since the kiln is designed to be kept in constant operation the year around, chambers or compartments must, of course, be emptied as soon as fired and cooled, whether shipped immediately or not. Portable conveyors now make it practicable to place brick in stock without excessive cost. The interest on the working capital thus employed is far less than the overhead on an idle plant, and there is no safer investment than in good, well-made and well-burned brick.

Another advantage of the continuous kiln that is now receiving considerable attention especially where the brick plants are situated in cities, towns or villages, is that such kilns practically eliminate the smoke nuisance. The time is coming when no manufacturer will be permitted to pollute the atmosphere where people reside with the black smoke from the improper firing of bituminous coal.

Conclusion

I have not expected to present anything that is new to most of the members of this Division, but feeling, strongly as I do, the duty of every brick manufacturer to conserve fuel and not needlessly waste it, especially when saving fuel so materially reduces the cost of his product, and knowing, as I do from many years' experience and observation and study, that the continuous, regenerative kiln, of an improved Hoffman type, is well adapted to the firing of common brick and hollow building tile, and is the most practical kiln for these products, I take this opportunity to urge you to investigate the merits of this system of firing, and when you are convinced, to use your influence to promote a more extended use in America of this fuel-saving kiln and thereby also bring into better repute brick as a structural material, by reducing the quantity of soft or salmon brick now produced to such an extent in the fuel-wasting up-draft kilns.

Ceramic Engineering Co.
Columbus, Ohio

THE VITREOUS SANITARY WARE INDUSTRY[1]

By W. A. Darrah

This discussion is intended as a summary of the vitreous sanitary ware industry, and a specific effort has been made to avoid a detailed technical discussion, in the belief that the basic facts will have a wider appeal than a technical discussion.

One of the objects of this paper is to point out that owing to the highly competitive conditions which now exist and which are rapidly becoming more marked, only those factories which are in position to manufacture ware with a high degree of economy and efficiency will be able to survive and show a profit.

The sanitary ware industry, like a great many of the allied clay products lines, is today passing from a condition of "rule-of-thumb" into a condition of highly practical, technical control of raw materials and manufacturing operations, including all steps up to the finished product. Without the proper control, competition will in the near future force plants operating by the rule-of-thumb out of business.

Vitreous sanitary ware in general includes such materials as bathroom fixtures, closets, tanks, lavatories, bathtubs, urinals, etc., kitchen sinks, washtubs, drinking fountains, bubblers, and a miscellaneous list of related equipment and fittings.

There are two classes of ceramic sanitary ware on the market in addition to the porcelain enameled iron ware, which has a definite field of its own. The first, *or better class of sanitary ware* is known as the "vitreous" ware, which is made from a white clay body, so compounded and fired at such temperatures that the material is dense, waterproof and vitreous throughout. This ware is of course glazed like all other sanitary ware, but the body of the ware is so dense that it has no appreciable absorption of moisture.

A standard, typical test for ware of this kind is the so-called "red ink test," which consists in spreading red ink over a broken portion of the ware and after allowing it to remain for five or ten minutes the ink is washed off. An examination of the ware will then indicate whether or not the ink has penetrated into the material. If no sign of penetration can be detected the test is satisfactory and the ware meets the requirements of the United States government and the municipalities and state regulations.

During times of competition much stress is laid upon the red ink tests, and all contracts sold to the United States government must satisfactorily pass this test. During normal conditions, however, very little attention is paid to this requirement providing the surface of the ware is dense, strong and well glazed. Even under conditions of considerable competition this

[1] Presented at the Annual Meeting, American Ceramic Society, Columbus, Ohio, Feb., 1925. (White Ware Division.)

test is mainly applied to closets, and the other articles are frequently not subjected to a critical absorption test.

The second class of sanitary ware is the so-called "porcelain body" or "porcelain sanitary ware," which is non-vitreous, and usually has a yellow or buff color body beneath the glaze. The body is highly absorbent of moisture, but when properly made is so well protected by the glaze that the finished article will give highly satisfactory service. Ware of this kind is used very largely for such articles as bathtubs, large urinals, kitchen sinks, washtubs, etc. Lavatories are frequently manufactured from this kind of body, but closets and tanks are almost exclusively made from the vitreous ware.

The so-called porcelain body ware as a rule presents a less satisfactory appearance than the vitreous ware and normally commands a lower price. Aside from the cost of materials, the manufacturing cost of the porcelain body ware is substantially the same as the cost of the higher grade or vitreous ware, so that it is more profitable for the manufacturer to produce the highest quality ware, thus securing the best price for his product.

The present discussion will be confined entirely to the manufacture of vitreous sanitary ware.

Relative Demand

Under normal conditions the principal products of the vitreous sanitary ware plant may be divided in approximately the following proportions among the various articles given in the table below.

Article	Per cent of product
Closets	40
Tanks	27
Lavatories	13
Bubblers	10
Miscellaneous	10

Local conditions will of course determine the relative number of articles produced, and, while it is not customary at most sanitary plants, too much stress cannot be laid upon the advisability of maintaining a relatively wide diversity of materials.

It is the writer's opinion from a careful study of the industry that the successful plants in the future will be those which maintain a relatively wide line of varying articles outside of the sanitary ware line.

General Notes on the Manufacturing Process

The clay working industries date from the earliest records of civilization, and until relatively recent times this very old industry has escaped the modernizing influence of mechanical and scientific development. Many factors have been responsible for the lack of progress in the clay working industries, but prominent among these is the fact that the primitive

methods produce reasonably satisfactory results in times of slight competition, and without taking advantage of the most modern equipment very little improvement was possible. This condition is rapidly changing, and, as will be pointed out in this paper, the writer strongly believes that only those plants can survive which have complete control of their raw materials and processes and which use modern equipment throughout.

The older method of manufacturing sanitary ware consisted in pressing the clay, having the proper consistency, into molds of the form which it was desired to produce. After the drying, the clay ware was removed from the forms, dried, fired, glazed and made ready for shipment.

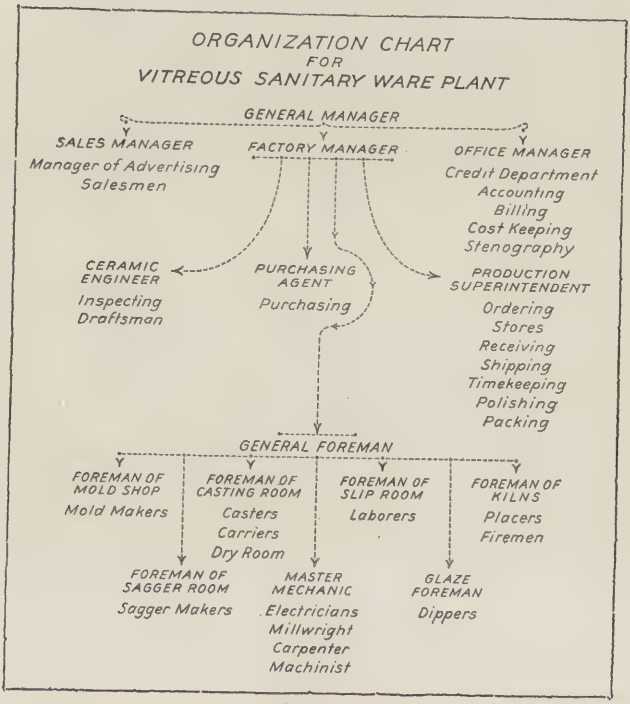


Fig. 1.

The above process, while relatively simple, is entirely dependent upon the skill and judgment of the workman, which has resulted in low output, attempted restriction of output by labor unions, increased costs and inferior quality of ware.

This discussion will ignore the above process (called "pressing") and will be confined entirely to the casting process, which, in the writer's opinion, is the only practical method to meet the quality and manufacturing costs demanded by present-day competition.

Casting Process

While the casting process as applied to clay products has been known and used for a long time, the specific methods of casting sanitary ware are relatively new.

The casting process is of particular advantage because it gives absolute control of the raw material, a close control of the manufacturing operations, and an absolutely uniform product with a minimum amount of skilled labor.

These advantages will be brought out in greater detail in the following discussion.

The casting process is of course only a group of operations in the complete manufacture of sanitary ware, and Table I shows in summary the various distinctive manufacturing operations, tracing the progress of the ware from the raw clay to the finished material on the shipping floor.

Steps in Handling Raw Material

The Materials The raw materials consist primarily of clay, flint, feldspar and the glaze materials, such as borax, silica, whiting and oxides of various materials, such as tin, lead, zinc, etc.

Clay, flint and feldspar are used in relatively large quantities, since the average slip may be said to be composed roughly of 50% clay, 25% flint and 25% feldspar. The above should not be considered as a working formula, as many factors must be taken into account, but the proportions mentioned will give a broad perspective of the quantities of the various materials employed.

Raw Material Storage To obtain the most satisfactory working conditions, the clay, flint, feldspar and related products, should be unloaded from the cars into suitable storage bins, which should preferably hold at least sixty days' working supply. Supplies of fire clay and material for making saggers and other refractory pieces, must also be stocked in working quantities.

Many of the higher grade clays may be purchased in a ground, pulverized condition, while the ball clay, and cheaper products are handled in the bulk or semi-raw state. A surprisingly large proportion of the clays used in the sanitary ware industry today are either imported from England or carried a long distance. While the cost of raw materials is not a large factor in the manufacture of this ware, there is at present considerable room for economy by the wider use of native clays in various localities. This involves some development but certainly no insurmountable problems.

The clays, flint and feldspar and other materials, are best collected from the bins by the sliphouse man in a scale car running along a narrow gage

track in front of the doors of the various bins. In the writer's opinion, a relatively intelligent man should be in charge of this process, as accuracy in scaling the various materials will well repay the expense involved, by maintaining uniformity and reducing losses in the various manufacturing operations and in the finished product.

Weighing and Mixing It is common practice to use an automatic scale car in which the weights are controlled by hooded levers so arranged that the workman is required to exercise no judgment, but merely care in counterbalancing each of the successive levers in the proper order. A scale car load ranges from 500 lbs. to 2000 lbs., depending on manufacturing conditions, but should preferably carry the complete manufacturing formula. After all of the levers have been counterbalanced by placing the proper amount of materials on the car, the car is wheeled to the elevator or conveyor and dumped. The elevator or conveyor delivers the materials to the blunger.

Blunging The blunging operation is one of considerable importance and must be allowed ample time to insure a thorough mixing of all of the materials and the production of a uniform, thin slip. Blungers for operations of this kind should preferably be free from exposed iron and either lined with tile or ceramic materials. Wooden linings may be employed but the depreciation and wear are quite rapid and the particles of the wood which are worn away of course enter the slip and occasionally cause trouble later in the manufacturing process. Blunging is continued for a period ranging from one to eight hours, depending on the nature of the raw materials employed. Four or five hours represents a common condition. In some exceptional cases a longer time is necessary. It is advisable to take all precautions to insure that no grease, oil or foreign materials enter the slip from the blunger or accessory machinery.

Lawning After the completion of the blunging period the slip is passed beneath an electro magnet and through a lawn, thus removing magnetic particles and lumps, pebbles, etc., which would of course be detrimental to the ware. A 120-mesh lawn is well suited for this preliminary step.

Pressing and Reblunging The slip after passing through the lawn is divided into two portions, one of which is returned to the slip blunger while the balance is passed to a filter press which reduces the moisture to 30 or 40%. The filter cakes from the press are then added in the proper proportion to the slip in the second blunger, together with the proper amount of electrolyte, and the mixture is blunged for the second time.

Addition of Electrolytes A number of materials are used for the electrolyte, but as a result of an extensive series of tests, it appears that a mixture of approximately equal

parts of sodium silicate and sodium carbonate give very satisfactory and quite uniform results. The amount of these combined materials will vary with the nature and character of the materials used in making the slip.

It has been developed by careful experimental work, that the hydrogen-ion content of the clay, as well as the fineness and chemical composition, very largely determine the quantity of electrolyte necessary. From $^1/_4$ of 1% to $^1/_2$ of 1% represents a common condition, and, as a rule, the proper quantities are determined by practical tests rather than on a theoretical basis.

Storage of Slip After the completion of the second blunging, the slip, which contains from 25 to 30% water, is passed under a second magnet and through a second lawn which usually runs about 90-mesh to the inch. The slip is then stored in the slip tank where it is kept in continuous agitation until used.

The time of storage, temperature of storage and degree of agitation, frequently exercise a very remarkable effect upon the characteristics of the slip. It is, of course, essential that the storage slip be kept absolutely free from the addition of ground water, waste or other materials, as extremely small percentages of various chemicals may have a disastrous effect later on in the manufacturing process.

The slip when prepared for final use ordinarily runs from 25 to 35% of water, and has a density about equal to thick cream. Slip of this kind will ordinarily measure from 28 to 30 ounces per pint, although the viscosity of the slip temperature and measurement, and many other factors are of prime importance, besides the weight of the slip.

Working Tanks From the slip tank the slip is pumped to the working tanks, which are normally located at a higher level than any of the rooms in which casting is being carried on. It is highly advisable that the working slip tanks be maintained at a uniform temperature and be not subjected to the varying conditions of weather.

For this reason slip tanks should normally be placed within the building, or if it is necessary to place them outside of the building or on the roof, they should be thoroughly enclosed and insulated against heat changes. If placed on the roof, or out of doors, proper provision for heating them should be made.

In all of the operations of handling the slip, the utmost care must be taken to maintain it clean and free from contamination at all times. Grease, splinters, particles of rubber, and materials of this nature, must be carefully avoided. Naturally particles of iron are extremely detrimental, as they will result in specks in the finished ware. Grease, wooden splinters, particles of rubber, and other forms of organic matter, frequently cause blisters, blowholes and related effects, some of which do not appear until the ware is fired for the second time.

Slip Piping From the working slip tank the slip is distributed by means of slip pipes to the molding benches where it is drawn off into molds. In some plants the continuous circulation system is employed in place of working slip tanks. This system has certain advantages but also involves some rather marked objections, so that it is the writer's opinion that in most cases a working slip tank system is preferable to the continuous circulating system. There are occasionally conditions under which the above situation might be reversed, however.

All slip piping should be inclined at a definite angle and provided with connections for thoroughly cleaning and washing it out, preferably with steam or with compressed air.

The Casting Process

The casting process of making sanitary ware is so simple and produces such consistently uniform results, that it is safe to predict that no other system of making ware of this class will be able to compete. Moreover, the great reduction in the necessity for skill and the elimination of the demand for trained men, has enabled the casting process to change the sanitary industry from one requiring skilled craftsmen to a commercial manufacturing business.

While, as previously stated, the casting of clay ware is not new, yet the manufacture of complicated shapes, such as those employed in the manufacture of closets for sanitary purposes, has resulted in the development of the hard body "over-casting," without which the sanitary industry would be seriously handicapped.

Over-Casting The method of over-casting consists primarily in casting separately several individual portions of the finished article, assembling them in a master mold and uniting the entire assemblage by casting additional slip around the units.

The Molds The steps in working out this process are clearly shown in the attached figures. Before passing to a discussion of the steps in casting, it may be pertinent to mention that the molds require some little attention and should be previously conditioned for moisture content before the casting operation proceeds. The mold which is too dry or the mold which is too wet will invariably cause trouble later on in the process. It is customary to dust the molds with pulverized dry body in order to reduce adhesion between the slip and the mold to a minimum. In casting, the mold should be filled evenly and accurately with the liquid slip, care being taken to avoid bubbles, drops of water or the inclusion of dirt.

Casting of Closets Figure 2 clearly shows the step of assembling the base of the closet in the plaster mold. The base has been previously cast in a separate mold in another operation.

It is of course cast from the same slip and in the same manner as the other portions of the article are cast. The foot must have the proper moisture content, that is, it must be dried for a proper period before it can be safely used in a further casting operation.

Figure 3 shows the step of placing the trap on to the foot. The trap has likewise been cast in a separate operation, and when dried to the proper consistency is ready for use. Later views will show the molds for casting the foot and trap.

It will be noted that only ordinary care and skill are required in placing the trap on the foot, as shown in Fig. 3. No especial training is required and it has been found entirely feasible to take a new man, unfamiliar with

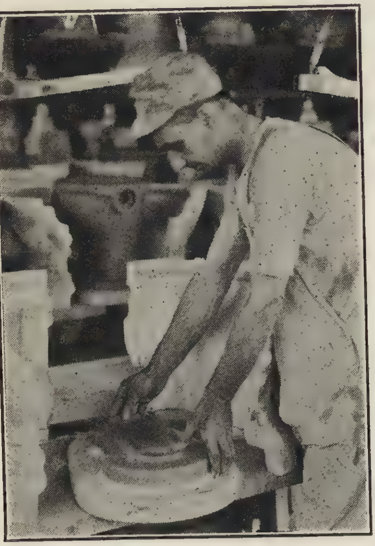


Fig. 2.—Placing foot in assembling mold.

Fig. 3.—Placing trap on foot.

pottery work. After giving him a training of two weeks he will be able to produce excellent ware. It is only necessary that the man have some inclination for mechanical work.

After the trap has been placed on the foot, as shown in Fig. 3, the main mold is assembled as shown in Fig. 4, including the trap and foot and providing spaces into which the additional slip later to be poured will run, uniting the whole combination into a single unit.

Inasmuch as the molds are duplicated from a set of master molds, and provided with proper spacing and locating notches, no skill or training is required for this step. After the two sides of the molds have been properly placed, as shown in Fig. 4, the top portion, which forms the depression

in the bowl, is set into place as shown in Fig. 5. The straps and clamps are next adjusted, holding all parts of the mold firmly in place during the casting process. It may be noted that the mold is not necessarily water tight, as any small leaks ordinarily promptly close themselves by the solidification of the slip.

When the mold has been assembled in the condition indicated in Fig. 5, the slip is poured either from a pail or flexible hose direct from the slip tank. As a further precaution it is advisable to pour through a screen or trap as shown in Fig. 6, as this removes any splinters, bits of organic matter, dirt, and even grease. The screen further serves the purpose of somewhat eliminating the rate of flow of the slip, and allows a better distribution of the slip than could ordinarily be obtained by discharging directly from the slip hose. In some plants the screen or trap is not used in pouring, but as a rule, the greater uniformity thus obtained amply warrants the slight additional trouble and expense involved. It appears to be a principle in sanitary plants (as indeed in all other ceramic operations) that uniformity of material and treatment are absolutely essential to success.

Fig. 4.—Putting mold together preparatory to casting bowl.

Fig. 5.—Putting on top of assembling mold.

After the mold has been poured it is allowed to stand for a period varying from two to four hours, depending upon the nature of the slip, condition of the mold and other factors. At the expiration of this time the slip is solidified sufficiently (due of course to the absorption of water by the

plaster) to permit of some handling of the clay body. The rim (which has previously been cast separately) is now placed on the top of the closet while still in the mold, and forced gently into close contact with the portion previously cast. In order to assist in a satisfactory union between these two parts, a roll of plastic body is ordinarily first placed upon the top of the closet previously cast.

The holes in the rim which distribute the water in the bowl are punched before the rim is pressed in place. Figure 7 shows this operation and the appearance of the rim before being placed on the closet. After the rim has been pressed into position the closet is completed as far as the casting and forming operation is concerned. It is allowed to stand in the mold for

Fig. 6.—Pouring the mold.

Fig. 7.—Putting rim on bowl in assembling mold—rim has been cast separately and punched.

a short additional period until it has reached a leather-hard state, at which time it is able to support its own weight without sagging, and has sufficient strength to permit trimming and smoothing seams, removing slight defects and placing it in final condition.

Proper judgment must be used as to the period that the closet is allowed to remain in the mold and the period that it is allowed to dry before the finishing and sponging operation. Inasmuch as the materials used are thoroughly standardized and the temperature and humidity conditions of the mold and atmosphere in the casting room are also thoroughly standardized, the drying time may be predicted very closely, thus again making

the operation merely one of manufacturing skill instead of requiring a highly trained operator.

Figure 8 shows above closet as it leaves the mold ready for preliminary trimming and drying.

Casting of Tanks The casting of tanks is a somewhat similar operation, although owing to the relatively simple contour of the tank the operations are fewer.

Figure 9 shows the core of the tank being prepared for casting. The core, which is of course of plaster of Paris, must have the proper humidity conditions, and is ordinarily dusted with some of the dried, pulverized body before assembling.

Fig. 8.—Bowl as it comes out of the mold ready for finishing.

Fig. 9.—Dusting core preparatory to assembling.

The sides of the mold are then placed upon the core, as shown in Fig. 10, after having been previously conditioned for humidity and dusted. When assembling, the mold is clamped and strapped in a firm manner in order to prevent displacement during operation.

The tanks, owing to their structure, can frequently be cast to advantage from the bottom, and can be poured slightly faster than is permissible in the case of forming the closets. The rising slip expands into two funnels at the top of the mold.

Figure 11 shows the operation of pouring the tank from the bottom. Funnels are used to maintain a proper head of slip above the upper portion of the tank. As in the case of casting closets, the tank is allowed to re-

main in the mold until it reaches proper consistency and is able to support itself. It will be evident that in all casting processes the core must be removed before the article being cast has dried sufficiently to cause shrinkage. Obviously, as drying and shrinkage take place, numerous cracks and defects will be caused if the cores are not promptly removed. Hollow corners sometimes result from this cause.

Figure 12 shows the tank removed from the mold.

The tank lids are cast in a separate mold, but after proper drying and finishing, are removed and pass through the final manufacturing steps in position on the top of the tank.

Figure 13 shows the lid mold being opened, and the lid inside.

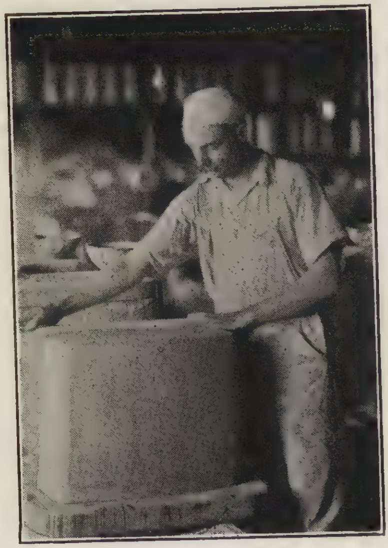


FIG. 10.—Assembling mold.

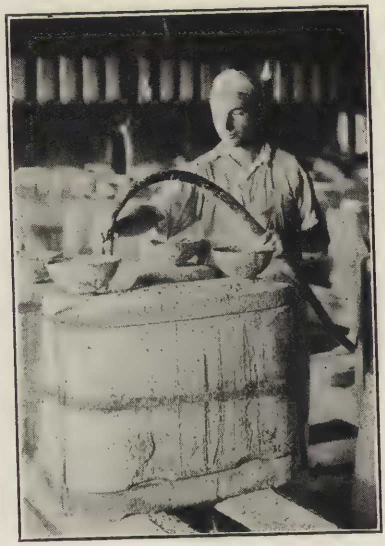


FIG. 11.—Pouring mold.

Figure 14 shows a general view in a casting room. In the left foreground will be noted a number of molds for casting tank lids. In the center of the picture is a workman clamping together a tank mold, while ware in other stages of manufacture will be noticed in other parts of the picture.

Drying

The drying of ware of this class is of great importance. This fact has frequently been neglected, as it is of course possible to secure certain mediocre results by merely permitting the ware to dry in an open room or when stacked around the kiln. When dried in this manner it is not unusual for from four to ten days to elapse between the casting operation

and the first firing of the ware. Aside from the fact that an extremely large space must be reserved for ware when drying at this slow rate, it will be evident that a very large stock of ware must always be carried in a leather-hard condition, which means a considerable amount of money tied up, inasmuch as the labor of manufacture, the overhead and the cost of materials must be defrayed before manufacturing is begun.

It is entirely feasible to reduce the drying time for sanitary ware of this class in question to a matter of hours, when using driers equipped with proper humidity control. An actual drying period of eighteen hours is readily obtainable, with excellent results. Obviously, the chances for damage to the ware, as well as the handling, the storage required and the

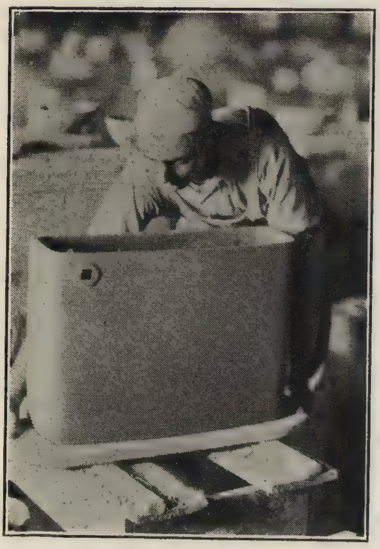


Fig. 12.—Tank as it comes out of the mold.

Fig. 13.—Opening lid mold showing cast lid.

capital tied up, are all proportionately reduced by a rapid drying. The drying cycle which has been found to give most satisfactory results, consists in subjecting the material to be dried to an atmosphere fully saturated with water vapor and maintained at a temperature close to 200°F. This condition is maintained until the ware is thoroughly heated through. After the ware is heated, the amount of moisture in the air is reduced, at the same time maintaining the wet bulb temperature constant. The result of this procedure is to avoid the formation of a case-hardening skin on the outside of the ware. The skin formed by surface drying would act to prevent further drying of the ware, or at least to greatly retard the rate of drying. On the other hand, by maintaining the humidity of the sur-

rounding air at the saturation point, there will be no appreciable transfer of moisture from the ware to the surrounding air during the heating period. On the other hand, at the conclusion of the heating period the temperature of the interior portions of the ware will be sufficiently high to force the moisture at these points to the surface, and the reduction in humidity of the surrounding air will then permit a transfer of moisture from the ware to the surrounding air.

A drier of this type consists primarily of an enclosed room, the walls of which are preferably well insulated, a blower of sufficient capacity to keep the air in the drying room in rapid circulation around all of the ware, and the necessary control devices and heating equipment.

Fig. 14.

A drying room of this type is relatively inexpensive and extremely effective, and it is the writer's opinion that humidity drying along these lines must be installed by every plant in order to meet the keen competition of today.

The ware may be handled either on a system of automatic conveyors, on a series of skids and skid trucks, or it may be placed in the drier by hand and removed by hand. Local conditions will determine the most satisfactory driving mechanism for each individual case. The mechanism, however, should be relatively simple, and if it provides an inexpensive means of transporting the ware, the whole object is accomplished. In general, for the drying of ware as bulky as that here described, a system of skids and skid trucks will give very economical and satisfactory results.

Finishing Drying in most plants may be divided into two stages, the first of which may be called the preliminary drying and the second the final drying. After the preliminary drying, which is commonly accomplished on racks or "stillage," the ware is given a final finishing, at which operation, irregularities, roughness, pinholes, etc., are removed as far as possible, by scraping or sanding. Some retouching with a wet sponge may be done at this time, although where possible scraping will give more satisfactory results from the standpoint of losses later on in the operation.

After finishing, the ware is placed in the dry room or returned to the stillage for the final drying.

FIG. 15.

Figures 15 and 16 show some of the finishing operations.

Final Drying The final drying, if carried on in the casting room, will require from one to two weeks, and under some conditions much longer before the ware is in condition to be placed in the kiln.

When dried in an automatic humidity drier, this operation may be completed on a 24-hour cycle and permit of a margin ranging from 4 to 6 hours for loading and unloading the drier. The humidity drier will therefore materially reduce the building space required for drying of ware in process of manufacture. The amount of saving of floor space by the humidity

drier may be calculated approximately on the assumption that ordinarily less than $^1/_{10}$ of the space occupied by the ware in drying will be required if a humidity drier is employed.

In all cases, however, the saving is not quite as large as might appear, for the reason that in a well-designed factory, the space above the casting benches is frequently utilized for stillage or drying of the ware.

An additional saving from the use of the humidity drier results from the reduced amount of ware in process of manufacture. For example, if a plant would normally produce 100 pieces of ware per day, which required 14 days for drying, there would obviously be approximately 1400 pieces of ware on hand between the initial casting and the initial firing operation.

Fig. 16.

On the other hand, if a humidity drier is employed there would be only slightly over one day's work, or approximately 100 pieces of ware. Assuming that the unfinished pieces represent an investment value of only $1.00 each, it will be apparent that $1400 will be continuously invested in unfinished ware without the drier, whereas only $100 would be invested where the drier was in use.

Firing

The firing operation in the case of sanitary ware is one of the large items of expense, and where not properly controlled also involves possibilities of considerable loss.

The tunnel kiln, in the relatively near future will displace practically all other types of kilns for sanitary ware. Possible exceptions to this rather broad statement will of course develop due to special local conditions, special fuel costs, and other items. Inasmuch as the subject of tunnel kilns for pottery ware has been fully discussed in many excellent papers, the writer will not go into this subject in detail at this time. In a later portion of this paper, estimates of firing costs will be given and discussed. In passing, however, it is of interest to note that the tunnel kiln materially reduces fuel costs. In many cases where the same fuel is employed, the ratio is as great as 6 to 1 in favor of course of the tunnel kiln. In the same way the tunnel kiln materially reduces the labor costs, inasmuch as the ordinary round type of kilns require considerable skill in placing, in drawing and in firing. Placing and drawing, in the case of the tunnel kiln, become a matter of common labor, involving practically no skill. Firing in the case of the tunnel kiln is a matter of maintaining pyrometer readings at a constant figure, and therefore practically eliminates the necessity for personal skill required in the case of the periodic kilns.

Fig. 17.

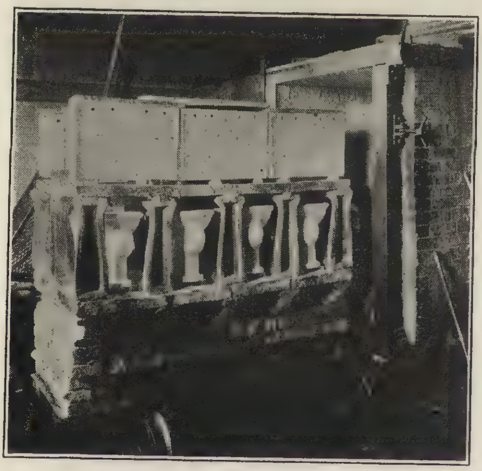


Fig. 18.

Figure 17 shows the interior of a typical periodic kiln in the process of being drawn. The laboriousness of the task is evident, and the pile of broken saggers, setters, etc., in the center of the floor, testifies to the mechanical breakage

involved. It will of course be evident also that the handling methods are extremely crude.

Figures 18, 19 and 20, show on the contrary, the operations of handling ware on tunnel kiln cars. The cars in question are used in a Dressler kiln but of course there are many satisfactory types of kilns upon the market.

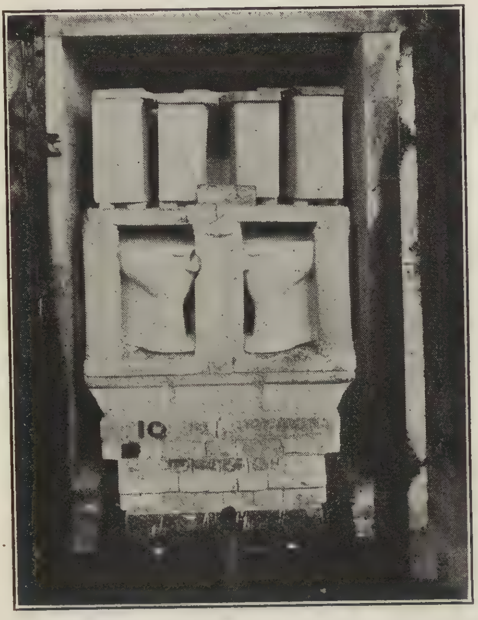


Fig. 19.

The firing cycle of sanitary ware is well known, and the limitations and restrictions to be observed have been fully discussed in previous papers. The upper limit for the bisque ware will usually run about cone 10, while glost ware may be fired as low as cone 6 or cone 8, depending on the exact formula used.

Glazing

Most sanitary ware is now manufactured by the two-fire process, although certain experiments recently made indicate that sanitary ware can be satisfactorily manufactured with a single fire, applying the glaze on the green ware. Further development along this line will result in materially lower manufacturing costs, which, as previously mentioned is the crying need of the industry.

Fig. 20.

As is well known, the major difficulty in producing high grade sanitary ware in a single fire arises not so much from troubles in applying the glaze to the green ware as it does from the lack of opportunity to repair or retouch defective pieces. In other words, the loss in a single-fire process has normally been considerably higher than the loss in a two-fire process, and this has hitherto restricted the wider use of the single-fire

process in connection with sanitary ware, although some few manufacturers are now using the single-fire process.

The glazing of sanitary ware is applied in many plants by merely dipping the ware in large tanks of prepared glaze, as shown in Fig. 21. While the glazing operation appears very simple, considerable mechanical skill is required to insure the proper thickness of coat and a uniform application over the entire surface.

The weight and viscosity of the glaze are of fundamental importance in connection with securing a smooth uniform result. Glaze is frequently found to change its covering power and mechanical characteristics with age as well as with temperature. Such defects as jumping, cracking while drying, etc., occasionally result from this source.

Fig. 21.

The bisque ware after having been dipped in glaze is dried on racks from 24 to 48 hours, depending on drying room conditions, after which it is placed in the glost kiln and fired.

The subsequent operations, such as unloading the glost kiln, inspecting, packing and shipping, involve few differences over ordinary white ware practice, and will not be further discussed.

Organization Chart of Vitreous Sanitary Ware Plant

Figure 1 shows a typical organization plan for a fairly large sanitary ware factory. In many factories employing 200 men or less it is possible to reduce the number of executives by increasing the duties of the individual men. The organization shown on the enclosed chart would be ample for a production of 500 to 1000 pieces of sanitary ware per working day.

Manufacturing Costs

The subject of manufacturing costs, in the opinion of the writer, is one of the most vital before the industry today, and success in reducing these costs to a minimum will determine which factors will survive and which will finally retire from the business.

It will be apparent that the detailed operations will vary widely in various plants, depending on mechanical equipment, skill of individual workmen, ability of executives, and other obvious factors. It is therefore obviously a dangerous expedient to specify an exact cost without surrounding the estimate with safeguards.

The enclosed Tables I and II should be considered with the above facts in mind, and are intended to be taken as representative of typical factory practice rather than of the first manufacturing conditions.

It will be apparent from a consideration of these tables, that a factory producing 500 pieces of sanitary ware per day would be involving a daily expense of approximately $2500, and this factor of course must be considered in connection with the financing operations necessary.

TABLE I

ANALYSIS OF ESTIMATED MANUFACTURING COSTS

Vitreous Closet Bowl with Spud—Packed for Shipment
(Weight 40 lbs.)

Materials in bins	$0.42	Dipping	$0.06
Labor and expense of prepg. mat. ready for molds	.35	Placing in biscuit kilns	.10
Casting labor, including finishing	.90	Firing glost	1.21
Carrying out	.03	Inspecting	.03
Drying	.06	Packing (labor and material)	.20
Placing in biscuit kilns	.10	Mold depreciation	.06
Firing biscuit	1.02	Sagger depreciation	.06
Inspecting	.03	Miscellaneous and overhead	.12
Trimming (where necessary)	.05	Spud	.19
Total factory cost			$4.99

TABLE II

ANALYSIS OF ESTIMATED MANUFACTURING COSTS

Vitreous Tank with Cover—Packed for Shipment
(Weight 60 lbs.)

Materials in bins	$0.65	Trimming (where necessary)	.06
Labor and expense of prepg. mat. for molds	.52	Dipping	.06
Casting labor, including finishing	.90	Placing in glost kiln	.10
Carrying out	.03	Firing glost	1.22
Drying	.06	Inspecting	.03
Placing in biscuit kiln	.10	Packing (labor and material)	.23
Firing biscuit	1.11	Mold depreciation	.06
Inspecting	.02	Sagger depreciation	.06
		Miscellaneous overhead	.21
Total factory cost			$5.42

Investment Required

In order to get a picture of the sanitary ware business from the standpoint of the executive or business man, it is helpful to consider the factory equipment and investment in relation to the value of the product produced and the earning capacity.

Table III gives a summary of the factory departments involved in a sanitary ware plant, while Table IV gives a rough estimate of the investment in machinery and equipment for such a plant. It should be kept in mind that Table IV does not include any investment for buildings, kilns,

TABLE III
TABLE OF FACTORY DEPARTMENTS

A. Main Manufacturing Department

1. Slip room (including clay storage)
2. Casting room
3. Drying room
4. Inspection
5. Firing or kiln room
6. Dipping (or glazing room)
7. Packing room
8. Warehouse.

B. Auxiliary Shop Department

1. Millwright shop (plumbing, sectional work, miscellaneous)
2. Machine shop for repairs, etc.
3. Glaze room for preparing glaze
4. Glaze kiln for fritting glaze
5. Carpenter shop for crating, etc.
6. Mold shop
7. Laboratory (for anal., tests, control, development, etc.)
8. Sagger shop
9. Stock room.

TABLE IV
LIST OF MACHINERY REQUIREMENTS
For Manufacture of Vitreous Sanitary Ware (Capacity 25 Tons of Clay per Day)

Item	No. required	Approx. total cost
Double blungers	3	$2520.00
Lawns	4	1800.00
Slip pumps	4	2400.00
Filter presses	2	2400.00
Scale car	2	1710.00
Elevators	3	1374.00
Ball mills	2	2400.00
Dry pans	2	3000.00
Pug mill	1	624.00
Slip storage tanks	2	2644.00
Electro magnets	4	1020.00
Motor drives for above equipment		5260.00
Machine shop equipment		4820.00
Carpenter shop equipment		2832.00
Millwright shop equipment		3820.00
Miscellaneous shovels, pails, scales, lawns, etc.		2600.00
Installation, labor and material		6148.00
Total		$47,372.00

or other equipment, which figures are given in Table V, except land and building.

TABLE V

LIST OF AUXILIARY SHOP EQUIPMENT FOR MANUFACTURE OF VITREOUS SANITARY WARE

Item	No. required	Approx. total cost
Drier (controlled humidity)	3	$7,350.00
Frit kilns	2	2,080.00
Service kilns	1	3,800.00
Tunnel kilns (2 for biscuit, 1 for glost)		350,000.00
Distributing slip tanks	6	
Clay storage bins	10	8,500.00
Piping, fittings, etc.		
Narrow gage track	600 ft.	1,240.00
Work benches		8,235.00
Racks		5,768.00
Miscellaneous tanks		4,200.00
Jigs and fixtures		12,000.00
Molds		32,000.00
Laboratory and equipment		10,000.00
Automobile trucks	2	7,600.00
Miscellaneous		18,000.00
Total		$470,773.00

TABLE VI

SUMMARY OF ESTIMATED TOTAL ULTIMATE INVESTMENT

Item	Amount
Shop auxiliary equipment	$120,773.00
Kilns	350,000.00
Machinery	47,372.00
Real estate (four acres)	100,000.00
Buildings	154,000.00
Miscellaneous	15,000.00
Total fixed investment	$787,145.00
Liquid capital requirements	200,000.00
	$987,145.00

In addition to the investment in fixed capital, shown in Tables IV and V, an investment in liquid capital must of course be considered. Such an investment will naturally depend upon the rate of turnover and size of operations. In the case of a plant having a capacity of 1000 pieces of sanitary ware per day, in the neighborhood of $200,000 liquid capital would be required. The total capital requirements then of such a plant are shown on Table VI.

Earning Capacity

The earning capacity of a sanitary ware plant is naturally largely dependent upon the market price for the product, the efficiency of operation, and many other variable factors which go to make up the total business hazard.

Naturally the sanitary ware business has prospered immensely in the years of large building activity, and conversely, it has suffered serious loss during periods of business depression.

Looking over the records of twenty-five typical sanitary ware plants in the United States for a period of years, the results show average earnings in excess of 10%, and in some years, earnings which in individual cases appear to approach 50% of the total investment.

The future of the sanitary ware business appears to be very bright, although there will undoubtedly be extremely keen competition, which will mean that the well organized, well managed companies will prosper, while some of the weaker and less efficiently organized companies will undoubtedly cease operations.

THE CONTINENTAL INDUSTRIAL ENGINEERS
CHICAGO, ILLINOIS

NOTE: The writer wishes to acknowledge the courtesy of the Universal Sanitary Manufacturing Company in permitting the use of the above photographs.

RESEARCH RESULTS APPLIED TO THE PLANT. WHY, WHEN, AND HOW[1]

BY MARION W. BLAIR

A clay plant poorly managed, with unknown costs, obsolete and wasteful methods and equipment, has become to my mind an economic menace. I regard it in the same light as I regard a possible fire, explosion, or any other preventable disaster and as much of a personal menace as is a rattlesnake or a copperhead—but I see more of plants than snakes, so if in this paper any statements seem to be more severe than necessary, this attitude of mind which I cannot avoid is my apology, and possibly explains why I continue to hammer along the same lines.

This paper is written and presented with the very definite object of provoking a discussion of the points involved, but if the distribution and assimilation is as slow in proportion to its importance as the published results of the recent kiln firing investigation most of the debating will be done by the next generation. I carried in my grip a copy of the report in question for six months before I even found a copy in any plant and never have I seen a published comment on the work which included information as to where and how a copy might be obtained. Later, such discussion as I have heard has led me to believe there is not a clear enough understanding in the industry as to what may or may not be considered research work and not a clear enough understanding as to the application of research results.

[1] Presented at the Annual Meeting, Columbus, Ohio, Feb., 1925. (Heavy Clay Products Division.)

Research is primarily the effort to establish facts or principles by careful seeking and study. The emphasis in this definition should be put upon the words *effort, seeking* and *study*. The clay industry does not seem to realize there can and must be a great deal of pure research without actually establishing anything as a fact, much less pointing out a definite application or making an immediate financial return, and it is not in the fact itself but in its application that the profit lies.

From the application of certain basic principles has been developed the whole electrical industry. But the facts disclosed by Faraday were regarded with idle curiosity for more than half a century and the so-called practical men said, "yes all very interesting but of what value." But the modern generator and motor are designed along lines laid down by the first experimenters and there now seems to be no limit to their practical usefulness.

It may or may not be fortunate, but facts are facts, mechanical laws may not be broken without disaster and there is no chance to bootleg where a chemical reaction is concerned. For instance, there is a limit to reducing the fuel consumed in drying or firing clay wares, a limit to the efficiency of apparatus in use, but in seeking to reach these limits the plant operator will spend a useless amount of money unless he knows in advance how far he may reasonably expect to go. It is in my opinion the province of the research worker to establish such limits as indisputable facts. With each step toward the limit, however, as disclosed by work already done it is possible to improve conditions and the application should be made immediately to existing apparatus. The recent kiln firing investigation disclosed the fact that many plants are firing certain typical materials in typical kilns with a definite amount of coal per ton of clay and a certain length of time—a condition which if it existed in all plants of that particular type would mean an unbelievable saving in cost. Therefore, the time is here to apply results that far. The first step for any plant in an attempt to make application of such information to its own operation would be to determine and make a record of its past or present practice. It is a fact that many plants do not even weigh their coal, a small percentage do, yet such weighing is profitable if only to check the coal actually received against the tonnage paid for. But is it necessary for a laboratory car to camp on a plant to weigh coal? So far as that plant is concerned the establishment of the actual amount of coal used would be the result of research and the determination of the amount used per ton of ware would be the application of that research to plant operation. If a reduction can be made then the research begins to pay a profit. The careful comparison over a period of time with the amount consumed in other plants as disclosed by published research would be a step toward the application to the plant in question. If the amount is found to be

below the average then that plant may have some information on firing which would be of benefit to the industry as a whole, but if it is more, then there is a very definite objective in following up the methods of control as disclosed by the research in question. The same method may be employed as to any other plant operation which has been made the subject of study or comparison.

The starting point is a record of present plant practice, which can only be made by the use of definite controlling apparatus, the simplest of which is a platform scale, and which can be extended to include recording pyrometers and thermometers and draft gages on through the equipment of a modern laboratory. But the amount of profitable apparatus is limited by the personnel of the plant organization and its ability to intelligently use such equipment or its capacity to receive and benefit by instruction in its use. The use of a pyrometer for the sole purpose of recording the sleeping time of the night firemen is a silly yet common conception of its use. One might just as well give the night watchman a lantern and lock it in the office for fear he will break the globe.

I have made the specific item of coal consumption the subject of this paper and have referred to the work of research on kiln firing because that item still looms large in excessive cost and as a worthy point of attack, but other departments are, of course, subject to the same procedure and the application of any research result may be determined by a study of existent conditions and an intelligent comparison with known or published facts.

There is, however, a confusion between research and engineering construction and between the result of the research itself and the application of the facts established. For instance, on the subject of material handling I would scarcely call the substitution of a planer for a steam shovel or the use of a drag line rig instead of team and scraper research—and yet suggestions through the press as to research to be undertaken would seem to warrant the belief that individual plant operators would impose the selection of such equipment for them on a bureau supported from a general fund and call it research.

You who are here may ask why I take up your time with such criticism and please remember, criticism may be friendly and commendatory as well as otherwise, you may all feel you have passed the stage where you need to discuss such elementary subjects, but if there happens to be here for the first time the representative or if in the printed page these remarks are read by the representative of such plants as I have seen and investigated the past year, and the effect is either to cause him to wake up or drop dead of shame I shall have been repaid.

I shall describe one or two and then I am done—

A plant in Michigan, producing 30 M brick per day of shale, situated

in a face brick market, allowing 25% to 30% of its output to go into 2nd and 3rd grade material from scum and rough handling, consuming nearly a month's time to turn each kiln, using a booster furnace to help out a waste heat drier, setting wet brick nearly half the time, consuming 2000 pounds of $6.00 coal per 1000 bricks, never used a pound of barium, never used forced draft in any form, and never made a real dollar. Such a plant and such operation is surely a menace to the entire industry and it cannot be considered in any other light.

A plant in Indiana with 16 good kilns and 19 tracks of drier, producing 52 M brick of indifferent quality used for face brick, production said to be limited by the drier, admitted to consumption of 1600 pounds of coal per 1000 bricks, kilns on fire for eight and nine days, would like to increase production but does not believe it can be done, not a thermometer or pyrometer on the place, cool their ware through the drier irrespective of requirements, and sell their output below all competition.

I leave for you to determine whether such plants need research or application of established facts, and whether or not your business is vitally affected by such apparent and gross mismanagement and lack of information.

St. Louis, Mo.

ACTIVITIES OF THE SOCIETY

ROSS C. PURDY RESIGNS AS SECRETARY OF THE AMERICAN CERAMIC SOCIETY

The Board of Trustees regrets to inform the members of the SOCIETY that Mr. Ross C. Purdy has announced his wish to discontinue as secretary of the SOCIETY on March 1, 1926.

The Board has been loath to grant this request and the members of the SOCIETY will be disappointed to learn that our secretary has found it necessary to give up the office in which he is serving the SOCIETY so well. This announcement is not, however, intended to serve as a tribute to the splendid work rendered by Mr. Purdy, who will continue as secretary of the SOCIETY during the remainder of his term. When he leaves the office, he has promised to be as active in constructive service to the SOCIETY as in the past.

A successor has not yet been appointed. The Board invites the coöperation of the SOCIETY in selecting a worthy successor of Mr. Purdy.

E. WARD TILLOTSON, President.

SUMMER MEETING, IN CANADA, JULY 4–11 INCLUSIVE, 1925

The summer meeting of the AMERICAN CERAMIC SOCIETY will be held this year from July 4 to 11 inclusive. The following schedule will be followed during this trip:

July 4—(Sat.)—Leave Rochester, N. Y. for night boat ride across Lake Ontario to Kingston.

July 5—(Sun.)—Day ride down St. Lawrence River through the rapids and Thousand Islands to Montreal. Re-embark immediately for night ride on the St. Lawrence to Quebec.

July 6—(Mon.)—In and about Quebec.

July 7 and 8.—(Tues. and Wed.)—Ceramic Mines and Plants south of St. Lawrence—Thetford, Sherbrooke, St. Johns and Montreal.

July 9 and 10—(Thurs. and Fri.)—In and about Toronto.

July 11—(Sat.)—Niagara Falls or Hamilton.

The Canadian Department of Mines, The Canadian National Clay Products Association and The University of Toronto are making detail itinerary and meeting plans, announcements of which will be made as they develop. Additional optional plans will be made for those who wish to spend more time in Canada.

The important thing is for you to mark July 4 to 11 inclusive on your calendar as a week of exceptional recreational and informational opportunity with fellow ceramists from all parts of the continent.

NEW MEMBERS RECEIVED FROM APRIL 15 TO MAY 15

PERSONAL

Alan I. Appelbaum, 333 Ardmore Ave., Trenton, N. J. President, International Products Corp.

NOTE: The SOCIETY is putting on a vigorous membership campaign during the month of June. Every ceramist should have the *Journal* and should be identified with this organization. Application cards will be sent on request.

Asher Atkinson, Jr., 49 Mine St., New Brunswick, N. J. Student.
Henry J. Cunningham, 91 Central Ave., Glen Rock, N. J. Student.
Walter B. Ebert, California Clay Products Co., South Gate, Calif. General Superintendent.
D. L. Gillett, Westfield Clay Products Co., Westfield, Mass. Treasurer.
Clinton R. Kennaday, D. U. House, New Brunswick, N. J. Student.
Roy Miller, 484 Kent St., Sydney, N. S. W., Australia. Representing Carborundum Co.
Bernard Moore, Stoke-on-Trent, England.
A. B. Morse, 3807 Brunswick Ave., Los Angeles, Calif.
William M. Myers, Bureau of Mines, New Brunswick, N. J. Associate Mineral Technologist.
Stuart M. Phelps, Mellon Institute, Pittsburgh, Pa.
Rodney T. Rouse, 164 College Ave., New Brunswick, N. J. Student.
Harold B. Sparks, Nashville Pottery Co., Nashville, Tenn. General Manager and Secretary.
Martin H. Thornberry, Box 608, Rolla, Mo. Associate Professor of Metallurgical Research.
Wilbur R. Wyckoff, Hertzog Hall, New Brunswick, N. J. Student.

CORPORATIONS

Clay Products Association, 913 Chamber of Commerce Bldg., Chicago, Ill. Geo. D. Lenth.
The Inland Fire Brick Co., 1252 E. 55th St., Cleveland, Ohio. Geo. S. Davies, President and Treasurer.
The Laclede Gas Light Co., Olive at 11th St., St. Louis, Mo. W. H. Whitton, Vice-President and Secretary.

Membership Workers' Record

	Personal	Corporation
Harry E. Davis	1	
Charles F. Geiger	1	
L. C. Hewitt	1	
H. A. Huisken	1	
C. J. Kirk	1	
W. L. Shearer	5	
E. Ward Tillotson	1	
Edward J. Vachuska	1	
Albert S. Walden		1
Office	3	2
	15	3

PERSONAL NOTES

M. L. Bell of the General Refractories Co. has been transferred from the plant at Danville, Ill. to Altoona, Pa.

R. R. Danielson of the A. J. Lindemann and Hoverson Co., of Milwaukee, Wis., delivered three lectures before the students in the Dept. of Ceramic Engineering, Univ. of Illinois, May 1 and 2. The talks were on "The Enamel Industry," and "Preparation and Properties of Enamels."

George P. Fackt, formerly General Manager of the Denver Terra Cotta Co., Denver, Colo., is now located with the Northwestern Terra Cotta Co., 2525 Clybourn Ave., Chicago, Ill.

Miss Mabel C. Farren of Pittsburgh, and formerly Secretary of the Art Division of the SOCIETY, is situated at Monmouth, Oregon, at the State Normal School.

J. Ellis Harvey has moved from Ridgway, Pa., to St. Petersburg, Florida, Box 1778.

Geo. F. Hersey writes that his address now is Suite 601, Western Mutual Life Bldg., Los Angeles, Calif. Mr. Hersey moved from Akron, Ohio.

Gordon Klein has recently taken a position with the New Castle Refractories Co., New Castle, Pa. Mr. Klein moved from Springfield, Ill., where he was employed by the Springfield Paving Brick Co.

G. W. Rathjens of Evanston, Ill. is now living in Fairbanks, Alaska.

Charles F. Ryan has recently resigned from the Russell Engineering Co., St. Louis, Mo., and is associated with the Thatcher Mfg. Co., Elmira, N. Y.

George R. Shelton, Ph.D., Univ. of Illinois, who has been teaching ceramics at the University of Saskatchewan, was recently appointed as Assistant Professor of Ceramic Engineering at North Carolina State College, Raleigh, N. C.

R. R. Shively, Chief Technologist of the B. F. Drakenfeld & Co., Inc., was recently made a director in the same firm.

L. G. Wassman of Chicago has affiliated himself with the Pacific Sanitary Mfg. Co., and is living at Richmond, Calif.

Prof. W. G. Worcester of the University of Saskatchewan sailed on May 2 for points in England, Holland, Germany, Czechoslovakia and France in the interests of the Lignite Utilization Board of Canada and the Bureau of Labor and Industries of the Canadian Government.

LOCAL SECTION MEETINGS

Pacific-Northwest Summer Meeting

Members of the three Associations of the Pacific-Northwest, *i. e.*, the Local Section of the AMERICAN CERAMIC SOCIETY, The Clayworkers' Association and the Brick Manufacturers' Association will hold their Summer Meeting on June 20, 1925, at Portland, Oregon.

A tentative program has been planned with the following addresses:

1. "Terra Cotta Roof Tile," by David R. Hood.
2. "Latest Improvements in Plant Construction," by Samuel Geijsbeek.
3. Ralph P. Stoddard, Secretary of the Common Brick Manufacturers' Association of America is coming from Cleveland, Ohio, with an important message.
4. "Soluble Salts in the Manufacture of Terra Cotta and Slip Coatings for Brick Work," by A. L. Bennett.
5. "The Value of Research in the Clay Plant," by Wallace Thoreson.
6. "What Kind of Ceramic Education Do We Want at the University of Washington," by Hewitt Wilson.

Members are especially urged to be in Portland during the week of the meeting because the Portland Rose Festival will make an added attraction during the same week.

Trips will be made through clay factories and an outdoor meeting and picnic up the Columbia River Valley.

Detroit Section

Dr. E. Ward Tillotson, President of the AMERICAN CERAMIC SOCIETY, was speaker at a meeting of the Detroit Section, April 30, 1925. The subject of his address was "Research in Refractories and Important Applications."

Following dinner and Dr. Tillotson's address, a business session was held and plans outlined for meetings next fall.

Sixty-five persons were present and many large corporations of the vicinity were represented.

St. Louis Section[1]

On May 13, the St. Louis Section of the AMERICAN CERAMIC SOCIETY had a dinner meeting at 7.00 P.M. at the St. Louis City Club and had as its chief guest, Ross C. Purdy, General Secretary of the SOCIETY; also invited guests, namely, Dr. Walter E. McCourt, Dean of Engineering; Prof. G. Ferrand, Head of School of Architecture, and Prof. Wuerpel, Head of School of Fine Arts, all of Washington University, St. Louis. Forty-seven were present at the dinner and fifty-one at the meeting which followed. Twenty members of the St. Louis Enamelers' Club attended.

The meeting was most enthusiastic, due to Mr. Purdy's presence. The evening was devoted to a general discussion of the question of a Ceramic Course; also a Research and Testing Laboratory at Washington University, enabling the local manufacturers of Ceramic Products to have their products tested and Research undertaken. It would seem most desirable to have a course in Ceramics and a Research and Testing Laboratory established at Washington University in St. Louis, where practically all types of ceramic industries are located. Mr. Purdy pointed out the fact, that at present there is a demand for twice as many Ceramic Engineers as are available from the present existing schools.

A Committee to investigate the requirements of the ceramic manufacturers with reference to a Research and Testing Laboratory was appointed with a view to directing their attention to the splendid equipment and facilities at Washington University; on what basis it could be utilized and other equipment added as required, including also the question of a Ceramic Course for day and evening classes.

Following is the Committee appointed by the Chairman:

Messrs. Chas. W. Berry, George Thomas, Frank G. Jaeger, Jacob Stocke, F. Holmes and L. C. Hewitt.

Frederick E. Bausch, Chairman, presided.

Those who attended the meeting were as follows:

Frederick E. Bausch; Ross C. Purdy, AMERICAN CERAMIC SOCIETY; L. C. Hewitt, Laclede-Christy Clay Products Co.; E. H. Wuerpel, St. Louis School of Fine Arts, Washington University; W. H. Weber, Roxana Petroleum Corp.; H. W. Weber, Russell Engineering Co.; J. L. Crawford, Laclede-Christy Clay Products Co.; Wm. W. Aulepp, Russell Engineering Co.; James Cox, Russell Engineering Co.; H. D. Cushman, The Ferro Enameling Co.; F. G. Jaeger, Superior Enamel Products Co.; A. H. Sullivan; P. J. McCullough, Scullin Steel Co.; Frank L. Kehl, The Brilliant Co.; J. Koeber, Wrought Iron Range Co.; Harry Grospoeler, Wrought Iron Range Co.; C. W. Berry, Mitchell Clay Mfg. Co.; Fred Talbot, Laclede-Christy Clay Products Co.; Clayton S. Haupt, Wrought Iron Range Co.; Marie Reginer, Silica Enamel Sign Co.; E. A. Eigenbrot, Buck Stove and Range Co.; John J. Lawler, Allied Industrial Products Co.; John Hartman, Karr Range Co.; Jack A. Rumer, Ferro Enamel Supply Co.; E. O.

[1] L. C. Hewitt, Secretary.

McFadon, Karr Range Co.; F. S. Markert, Belleville Enameling and Stamping Co.; W. B. Halley, Buck Stove and Range Co.; Julius A. Kayser, Laclede-Christy Clay Products Co.; W. F. Godejohn, Laclede-Christy Clay Products Co.; Henry W. Perry, Laclede-Christy Clay Products Co.; F. J. Stretch, Koken Company; P. Buettner, Porcelain Enamel and Manufacturing Co.; Foster Holmes, Evens and Howard; B. W. Willson, Evens and Howard; Y. R. Anderson, Evens and Howard; J. D. Robertson, Robert W. Hunt Co.; Wm. D. Thompson, Laclede Gas Company; H. B. Holman, Laclede Gas Company; T. E. Wood, Laclede Gas Company; H. E. Weightman; H. V. Farr, Mallinckrodt Chemical Works; A. E. Hug, Roesch Enamel Range Co.; Henry Oesterle, Roesch Enamel Range Co.; Bernard Enter, Buck Stove and Range Co.; Frank G. Roberts, Porcelain Enamel and Mfg. Co.; Gabriel Ferrand, Washington University; W. E. McCourt, Washington University; Fred Schwetye, Missouri Fire Brick Co.; Geo. Thomas, Highlands Fire Brick Co.; Mr. Gosrean; Mr. Stocke.

Pittsburgh Local Section Meeting

The Pittsburgh Section of the American Ceramic Society held its annual election of officers last Friday evening in the Mellon Institute, at which the following officers were elected to serve for the current year: Chairman, E. J. Casselman; Vice-chairman, C. E. Nesbitt; Secretary, Foster Robertson; Treasurer, H. A. Willetts; Councillor, Francis Walker, Sr.

The election was followed by a paper by the retiring chairman, J. W. Cruikshank, who talked on the plate glass industry, tracing the progress which has been made and culminating with the present conditions of that industry. A diagram was shown giving the production and consumption of plate glass from 1885 to the present time. Mr. Cruikshank showed a number of lantern slides of factory views and equipment, showing old casting kilns and various methods used in former years.

CHAIRMAN OF MEMBERSHIP COMMITTEE APPOINTED

President Tillotson has announced that R. R. Shively of the B. F. Drakenfeld & Co., Washington, Pa., has been appointed Chairman of the Membership Committee of the Society. A list of the members of this Committee was published in the May *Bulletin*.

IN MEMORIAM

Richard R. Hice

Richard R. Hice unselfishly contributed several years of his life to the gathering and making public records of exact information about the ceramic materials of Pennsylvania. His business was the manufacture of face brick. He was well informed, practically, concerning the manufacture of clay products generally. His knowledge of geology, particularly of Pennsylvania, resulted in his appointment over a term of several years as State Geologist. His broad and fundamentally sound ceramic knowledge coupled with his generous desire to share with others brought to him the highest possible positions of honor and service in several societies.

Expressions of personal appreciation were not withheld from him while he was yet active. If opportunity were given our pages would be filled with many expressions such as are here given. These are from his associates with whom he labored so faithfully and successfully from the earliest for this Society.—Editor.

The announcement of the death of Richard R. Hice comes as a great shock. One by one we are passing on.

Hice was present at our first meeting at Columbus in 1899. I have a picture of a group of seven taken on the steps of Orton Hall. Hice is one of them. I also have his signature as president on the charter granted to the student branch here in 1915.

He was a man widely informed in the field of geology which he had chosen and yet he was unassuming. I always enjoyed his genial disposition. CHAS. F. BINNS

The departure of Richard R. Hice, one of our presidents, leaves his friends and former associates with a distinct sense of loss and of sadness. While few of us had the opportunity of seeing much of him during the last few years many of us came in contact with his vigorous and refreshing personality during the more active period of his life. The writer had the pleasure of a long continued acquaintance with Dr. Hice while he was State Geologist of Pennsylvania and while he was connected with the clay industry of the Beaver Valley.

In the course of many conferences and talks I learned to appreciate his wise counsel and the plain practical sense of our friend who had the ability to clear away all the extraneous parts of a proposition and come down to its essentials. He was a foe of all pretense and was not slow to oppose it. Dr. Hice was loyal to his friends who could always count upon his help and assistance. He was above all meanness and smallness.

The great interest of his life was the economic geology of his beloved Pennsylvania, a state which he served faithfully, often under very discouraging circumstances. At the same time he was much concerned with the work of the AMERICAN CERAMIC SOCIETY and was a constant supporter of its work.

The departure of Richard R. Hice is mourned sincerely by his old associates and his loss leaves a gap in a group which exemplified the spirit of service in no mean degree.

A. V. BLEININGER

The SOCIETY and his many friends suffer a great loss in the death of Mr. Hice. Always anxious to help others from his great store of knowledge, always so friendly and cheerful, his presence at our meetings was an assurance that we would be well paid for any effort spent in attending them. He has gone to his reward but still he will always be with us as his old friends will never forget him. STANLEY G. BURT

I cherish many memories of association with him in the olden days, memories that are now sacred. He was so unassuming, so well posted, so loyal and helpful, that, although I had not seen him for a long time, the memories of the old times were always with me. He did good service and at the time it was needed and counted big.

WM. D. GATES

I was shocked to hear of Mr. Hice's untimely death and with his passing I have lost a friend, an associate, and a genial and lovable companion.

I saw him for the first time on the deck of an excursion boat during the meeting of the N. B. M. A. in Pittsburgh in 1898 when the AMERICAN CERAMIC SOCIETY was born and the thought came to me that there was a man worth while and one whom I wished to know. I came to know him, met him year after year, and my admiration of him, regard for him and appreciation of his fine character, ability, and conscientiousness grew each year.

His was a nature that thought deeply, not given to idle chatter, and when he talked it was direct to the point, without hesitation, and well worth listening to.

When he took you by the hand, looked you in the face, there was no doubt he meant it, and in all the years since I first met him in personal contact with him, in an occasional

letter seeking information from him, there is not a single instance to change in the slightest degree the high esteem in which I held him.

It is not the many words, lightly spoken, making no impression and soon forgotten, that count, but instead the fewer words sincerely meant, and thus I came to know and appreciate Mr. Hice.

I deeply regret that he is gone and I will miss him but I shall ever hold him in cherished remembrance.

ELLIS LOVEJOY

With some men, their face is their passport across the frontiers and through the custom houses of acquaintanceship. It leads them on into the sunny parlors of friendship and trust. Such a man was Richard R. Hice. One knew instinctively in his presence that he was confronted by a prince among men. His fine vigorous figure, his large beautifully modeled head, his clear blue eye and his kindly expression, all seemed only a suitable casket for the serene gem of his spirit. So full of candor and honesty, so generous and courtly, so anxious to believe well and so loathe to believe ill or even hear it—and withal, so keen and discriminating in his intellectual powers, so imbued with a passion for the truth.

Hice came into the AMERICAN CERAMIC SOCIETY in its early days, when the circle was small and everyone knew everyone. Primarily a geologist, but with his attention directed toward the study of clays partly by financial interest, and partly by the fascination of the wide unexplored vistas which the least scientific research in that field opened up, he not only at once won his place among us, but broadened the viewpoint and strengthened the grasp of all of us on the fundamentals of our Industry—the Raw Materials.

Although Hice was not a geologist of great prominence or a chemist or ceramist of outstanding productiveness, he was preëminently dependable and sound in his contributions to all three sciences.

While those of the SOCIETY who never knew him, may wonder why we appraise his work so highly, the reason is no secret to the little and fast narrowing circle who knew and loved him. His work seemed to be a part of him—to be imbued with his own genial character. The meetings will never be quite the same to us again. His place cannot be filled.

EDWARD ORTON, JR.

So, Hice has been taken from us! Even though we have seen little of him in the past few years, it is a shock to be informed that we will never see him again. The SOCIETY has been fortunate in retaining its charter members. These were men of high character and their usefulness to the industry continues, though the work of the SOCIETY has naturally fallen into the hands of younger men. Hice was not old, and could reasonably be expected to still further add to his accomplishments.

I esteem it a privilege to have known him and to have associated with him during the years of his active interest in the clay industries. I have consulted him on certain clay formations of Pennsylvania and he has been ever ready to give of his knowledge to the individual as well as to the SOCIETY. His genial nature and sympathetic interest in our problems made it a pleasure to meet him.

He had many friends who will miss him. Our SOCIETY has lost a man who did much for it in the years when it needed, and fortunately received, the coöperation of its entire membership. Though many of us still keep in touch with the activities of the younger members and enjoy their companionship, yet we cannot, in the large membership, get as close to each other as we did in the first years of our organization. We love the old members, are always happy to meet them, and are always grieved when any one of them passes away.

Hice, you have done much to help us. We will not forget you. The old guard will close ranks and continue the work.

W. D. RICHARDSON

The brief notice of the death of Mr. R. R. Hice came as a great shock to me. I had known Mr. Hice for a number of years both as a friend and a fellow scientist. Throughout all this period I had always felt a warm regard for him, not only because of his interest in scientific and technical subjects, but also because of the good fellowship and sincerity of character which he always exhibited. His loss will be keenly felt by all of us in the AMERICAN CERAMIC SOCIETY who had known him ever since the date of its organization.

H. RIES

It was with great regret I learned of the death of another charter member of our AMERICAN CERAMIC SOCIETY. I am sure not only charter members but also our more recent members are made sad.

EDWARD C. STOVER

In the recent death of Richard R. Hice, a charter member, we have lost an enthusiastic veteran who was always keenly interested in the advancement of the SOCIETY. For several years he was interested in the manufacture of heavy clay products when the business was largely on a rule-of-thumb basis and he warmly welcomed the formation of an organization that was based on an intelligent, scientific study of its problems. He was a valuable contributor to the discussions at the SOCIETY meetings and was usually present at the summer excursions for visiting the operating plants.

In addition to being a practical ceramist, he was quite active as a geologist and for several years was at the head of the Pennsylvania Geological Survey. In this work he not only pushed the study of the Pennsylvania clays, but also made valuable contributions to the oil and gas industry.

By nature an optimist, he was overflowing with life and energy and was broad enough to change his views in the light of later information. He had a warm, charming personality that endeared him to his associates, who realize that they have lost a loyal, true friend and a valuable contributor to the ceramic industry.

H. A. WHEELER

Resolutions by Board of Trustees

Another charter member and past president of this SOCIETY has passed away. He recorded a wealth of useful ceramic information from which has been developed a great deal of the present ceramic information and manufacturing practices. He gave unselfishly of his time and ability. He loved his fellow men and earned the respect and confidence of all with whom he contacted. He was a scholar respected in the highest science circles. He was an investigator gifted with discernment and vision. He was a worker untiring and generous. He was a man fascinating and forceful. He will be greatly missed. The Board of Trustees of the AMERICAN CERAMIC SOCIETY therefore unanimously resolves,

WHEREAS, in his prime and when he was contributing largely to ceramic science and technology he was stricken and finally taken, and;

WHEREAS, he had for several years devoted a large portion of his time and ability to developing exact ceramic information and was ever anxious to do more, and;

WHEREAS, his generous human qualities brought him into relations which made his vast fund of ceramic information and his keen searching and proof-finding capacity readily available, and;

WHEREAS he served generously from the beginning as member and officer of the AMERICAN CERAMIC SOCIETY;

BE IT RESOLVED that (1) we, the elected members of the Board of Trustees for and in the name of the members of the SOCIETY, here record the appreciation which was broad and without exception of Richard R. Hice for the scholar, the worker, the man, and the fellow he was; and (2) the loss sustained by the many who were known by him and by

the much larger number of his admirers who knew him only by records of his extensive researches.

BE IT ALSO RESOLVED that this record be made in the *Journal of the American Ceramic Society*.

E. WARD TILLOTSON, *President*

REPORT OF STANDARDS COMMITTEE FOR 1924–25

Since the resignation of W. A. Hull as Chairman of this Committee, in the spring of 1923, three meetings have been held.

September, 1923 Meeting

The first meeting was called in New York City on September 19, 1923, and was productive of encouraging results. The tentative specifications as published by M. F. Beecher, then Chairman, in the 1921–22 year book were considered and the following business transacted:

(1) Specifications for: (*a*) Sampling Ceramic Materials as Delivered (revised); (*b*) Method for Slaking; (*c*) Scale for Testing Sieves; (*d*) Definitions for Clay Refractories; and (*e*) Method of Test for Refractory Materials under Load were passed and submitted to the General Secretary for vote by the SOCIETY.

(2) Specifications for: (*a*) Sampling of Clay Deposits; (*b*) Chemical Analysis; (*c*) Sag Test; (*d*) Transverse Strength Test; (*d*) Methods for Testing Electrical Porcelain; and (*e*) Methods and Apparatus published in the Appendix (1921–22 Report) were not passed by the Committee but are being continued as tentative.

In addition to the above, the Committee (1) revised, passed and submitted to the General Secretary for vote by the SOCIETY (*a*) Specifications for Whiting, and (*b*) Specifications for Limestone, Quicklime and Hydrated Lime for the Manufacture of Glass. (2) Returned to the General Secretary, for subcommittee to the Divisions in which they originated, Specifications for Flint and Feldspar, together with recommendations and suggestions for their revision.

February, 1924 Meeting

At the time of this meeting at Atlantic City, on February 5, 1924, the status of Standards, Tentative and Proposed, had remained unchanged.

Mr. Poste reported the work of the Enamel Division on "Acid Tests for Enamels," but stated that the Division did not favor the publication of the results at this time.

A. S. Watts submitted the following definitions, which were developed by Committee C 10 of the American Society for Testing Materials, for consideration:

Clay An earthy or stony mineral aggregate, consisting essentially of hydrous silicates of alumina, plastic when sufficiently pulverized and wetted, rigid when dry and vitreous when burned to a sufficient temperature.

Surface Clay An unconsolidated, unstratified, sedimentary clay with well-marked cleavage parallel to the bedding.

Fire Clay A sedimentary clay of low flux content, usually associated with coal measures.

It was voted that these definitions be printed as tentative.

Prof. Orton addressed the meeting on the importance of research on pyrometric cones to establish the relation between softening point, temperature and time. Prof.

Orton reported on the data which he had obtained in an investigation conducted at his plant on the relative softening points of various makes of pyrometric cones.

E. E. Pressler also addressed the meeting and explained in as much detail as the limited time would permit, a system of clay tests developed by him at the Ohio State University.

It was passed that the Chairman be instructed to appoint a committee to coöperate with the Bureau of Standards on a proposed investigation of pyrometric cones.

From a general discussion of the duties of this Committee it was obvious that the majority of the members favored the policy of having the Chairman assign to the special divisions constituting the committee definite problems for solution. Accordingly the following assignments were made:

Committee on Definitions (A. S. Watts, Chairman.) Define the terms: (1) *Porous*, (2) *Semi-vitreous*, (3) *Incipient Vitrification*, (4) *Vitrified*, and (5) *Maturing Temperature*.

Committee on Raw Materials (D. W. Ross, Chairman.) Consider: (*a*) Specifications for Quicklime and Hydrated Lime for the Manufacture of Silica Brick (Bureau of Standards Circular No. 153); (*b*) Tentative Specifications for Flint. (Note: The Specification for Silica Sand for Glass Making has not as yet been officially presented to the Standards Committee by the Glass Division); (*c*) Tentative Specifications for Feldspar (1921–22 Report).

Committee on Tests (G. A. Bole, Chairman.) Consider: (*a*) "Tentative Method for Conducting Draw Trial" (1921–22 Report Appendix); (*b*) Work presented to the Committee by E. E. Pressler.

Committee on Products (C. F. Geiger, Chairman.) Consider: "Proposed Federal Specifications Board Specifications for Fire Clay Brick, and for Fire Clay." (Note: The Specifications for Fire Clay Brick has since been adopted by the F. S. B. as Specification number 268.)

February, 1925 Meeting

The meeting was called at 5:20 P.M. on Wednesday, Feb. 18. Due to the unusually large number of interesting papers on the several Divisional programs, and the fact that no time had been set aside for Committee meetings, it was practically impossible to get together a quorum.

The following members were present: M. C. Booze, G. A. Bole, C. F. Geiger, A. S. Watts, R. F. Geller.

Mr. Geiger, as Chairman of the Committee on Products, had no formal report to make. After a limited discussion it was decided to submit the specifications for Fire Clay Brick as adopted by the Federal Specifications Board, but omitting the Simulated Service Test, to the Committee as a whole for approval, by ballot, as tentative.

The Committee on Tests, through Mr. Bole as Chairman, submitted a voluminous report indicative of a careful consideration of the revised methods for clay testing presented to the committee by Mr. Pressler. The following summary of conclusions was presented by Mr. Bole: "(1) That the material be worked up into a system of tests with full instructions as to method of carrying them out. (2) A justification for each test. Where possible the justification should take the form of comparative data to show that these tests are superior to methods now in use. (3) That the several tests be checked in several laboratories. I will be willing to endeavor to make arrangements for the various laboratory tests through our committee after Mr. Pressler has completed the first two phases of the work."

D. W. Ross, as Chairman of the Committee on Raw Materials, had formally submitted the following recommendations prior to the meeting:

(A) That the "Specifications for Quicklime and Hydrated Lime for use in the Manufacture of Silica Brick" as given in Bureau of Standards Circular Number 153 be submitted to the AMERICAN CERAMIC SOCIETY for confirmation or rejection as a tentative specification, if, and as soon as the A. S. T. M. confirms it as a standard specification for that society.

(B) That the development of specifications on flint and feldspar be left entirely to Frank Riddle's Committee of the White Ware Division until said Committee shall have made their final report on the subject.

The Committee on Definitions, with A. S. Watts as Chairman, was also very active during the past year. While progress is being made, no definite conclusions have been reached, and it is hoped that the interest of this Committee in developing definitions for certain ceramic terms will not lag during the coming year. Chairman Watts also wishes the attention of the Committee called to the following definitions which had been revised and adopted as standard by the A. S. T. M.:

Clay An earthy or stony aggregate consisting essentially of hydrous silicates of alumina, plastic when sufficiently pulverized and wetted, rigid when dry and vitreous when burned to a sufficiently high temperature.

Surface Clay An unconsolidated, unstratified clay, occurring on the surface.

Fire Clay A sedimentary clay of low flux content. (NOTE: It is usually associated with coal measures.)

Shale A thinly stratified, consolidated sedimentary clay with well-marked cleavage parallel to the bedding.

The Chairman was requested to submit the recommendations of Messrs. Ross and Watts to the Committee as a whole.

It has long been felt by various members of this Committee, and was again expressed at this meeting, that the Standards Committee and other Committees general to the SOCIETY be required to report to the SOCIETY at the annual meetings. It has been noted with considerable satisfaction that the tentative schedule for the meeting in Atlanta provides a time for such reports.

There was placed before the Committee for consideration the proposition of discontinuing the Standards Committee as an organization for the aggressive promotion of standards and tests for ceramic material, and to reorganize simply as a passive committee whose functions would be to supply the necessary contact with other associations and societies in their work on standards and tests. It was the opinion of the committee that it is not possible, with the present organization, to progress as rapidly as might be desired or to obtain the necessary personnel and finances to insure such progress; however, it was not felt that the committee should at this time approve steps as drastic as outlined in the original proposition.

The Chairman, in accordance with the instructions of the committee, had appointed P. H. Bates as representative of the Standards Committee in the special Commission to promote, and coöperate with the Bureau of Standards, in the investigation of pyrometric cones. This Special Commission consisted of Ed. Orton, Jr. and W. E. Mayer (producers); and M. C. Booze, James Turner, P. H. Bates (Chairmen), and W. H. Fulweiler (non-producers). Following a conference[1] with the members of the Bureau staff, and aided by direct financial aid from Prof. Orton, active work was started on two distinct lines of work: (1) the accurate determination of the relation between cone composition, temperature of softening, and heat applied (under C. O. Fairchild); (2) the de-

[1] The Bureau had considered the problem and constructed one furnace prior to the meeting.

termination of the relative softening points of typical American, English, German and French Cones (under R. F. Geller).

Due to exacting nature of Mr. Fairchild's work it was not possible in the first phase of the work, to advance much beyond the establishment of test methods and apparatus. In the second phase it was possible to complete the work for cones ranging from 010 to 20 and it is believed that the relative softening points of the four makes of cones tested had been fairly well established in the range given. A report of this work was made to the SOCIETY in General Session on Wednesday, February 18.

The Committee adjourned at 6.05 P.M. with the time of the next meeting left to the call of the Chairman.

While this Committee, as stated by some members, may be "making satisfactory progress" the actual work accomplished is so lamentably small as to seem hopelessly insignificant when compared with that which remains to be done.

At the present time the SOCIETY has: (1) Six accepted standards; (2) Seven methods and specifications recommended for acceptance as standard; (3) Eight (including silica sand) tentative methods and specifications.

The six standards were adopted in 1920 and should be carefully reconsidered to ascertain whether or not they still represent the best available data on the subject.

The seven recommended for acceptance could probably bear reconsideration by this time, for, here again, the progress of the industry in two years may have made certain details obsolete.

The eight tentative methods and specifications should either be recalled or revised, if necessary, and passed. It has been said that in this age one must "run to stand still," from which we are left to infer that "to stand still is to deteriorate." A specification is seldom a fundamental truth, but rather the nearest to the truth that can be determined with available data and must accordingly be changed as the data changes.

In addition to the above the committee should at least formally consider the following results of Federal Activities:

B. of S. Cir. 119. Spec. for Lime Flint Glass Tumblers.
164. U. S. Govt. Master Spec. for Flat Glass for Glazing Purposes.
118. Limestone, Quicklime and Hydrated Lime for Use in the Manufacture of Glass.
121. Glass Tableware.
243. Vitrified Chinaware.
122. Glass Lantern Globes and Lamp Chimneys.

DIV. OF SIMPLIFIED PRACTICE

B. of S. Cir. 7. Face Brick and Common Brick.
5. Hotel Chinaware.
?. (Cafeteria and Restaurant.)
1. Paving Brick, Vitrified.
10. Milk Bottles and Milk Bottle Caps.
12. Hollow Building Tile.

The work of this Committee peculiarly demands the active coöperation of technical organizations either through representatives on the Committee itself, or in their respective Divisions. Therein lies, no doubt, one of the principal reasons for the slowness of progress. It is customarily accepted that one man, on any Committee, does practically all the work; "one man definitions," however, are rarely practicable.

In this connection it is a noticeable fact that such progress as has been made is directly traceable to a few men (past and present) on the Committee itself and to Federal and University Laboratories. Active interest is not characteristic of the industry, and specifications will inevitably pine away and die without that interest.

It is also believed that the work of the Committee could be greatly assisted if it were possible to finance the expense incident to at least three meetings a year. This would help in two ways: (1) The SOCIETY would take an active interest in the work of the Committee if it had money invested in it; (2) The Committee itself would feel a moral obligation to make some return for the money expended by the SOCIETY.

Due to the summer meeting being scheduled for Toronto it will probably be impossible to hold a meeting prior to the next annual Convention. Little progress can be expected but if the Standards Committee wishes to maintain its identity among the living, those of its members who represent divisions will have to preach the gospel in those divisions to the end that at least a few of the assignments indicated in this report may be brought nearer to completion.

Respectfully submitted,

R. F. GELLER, *Chairman*, Standards Committee.

Bureau of Standards, April 11, 1925.

CZECHOSLOVAKIAN CERAMISTS TO BE HOSTS

Rudolph Barta, General Secretary of the Czechoslovakian Ceramic Society has issued an invitation to the members of the AMERICAN CERAMIC SOCIETY to join in a meeting of the three Ceramic Societies, in Prague, Czechoslovakia, in March, 1926. The English Ceramic Society will be there and it is supposed that the German Ceramic Society will also join the meeting.

NOTES AND NEWS

NOTES FROM BUREAU OF MINES

Domestic vs. Foreign Clays

The Bureau is receiving samples of English china clays from commercial shipments, sampled as delivered. These clays are to be tested as to their chemical, physical, and microscopic properties in the laboratory, concurrently with their commercial utilization. In this way it is hoped that information will be obtained that will throw light upon the quality of clays now received into this country, against which considerable complaint has been raised among users. The investigation is being undertaken at the request of the Research Committee of the U. S. Potters Association, A. V. Bleininger, Chairman.

Mr. Helser to Lisbon

Mr. P. D. Helser who has been with the Bureau for the past two years in the capacity of ceramic engineer and assistant superintendent of the Columbus Station has severed his connections with the Bureau of Mines to take a position at the Lisbon plant of the R. Thomas and Sons Company. It is with regret that the Bureau loses Mr. Helser. It is just another example of the oft repeated performance of a good man becoming better equipped and better known through Bureau service and being taken into the industry to become a valuable unit in our industrial development. Well trained men are the most valuable product the Government Bureaus can offer industry.

Dolomite Clinker

Dolomite clinker resulting from the experiments which the Bureau has been carrying on during the past five years is being produced at the rate of 100 tons daily at a commercial plant and is being tested

on a large scale at several open hearth plants throughout the country. The tests so far indicate that it is giving superior service to any commercial clinker.

Pullman Laboratory The laboratory car Metchnikoff has been transferred from the Medical Department of the U. S. Army to the Department of the Interior, Bureau of Mines, and has been made available to the Ceramic Experiment Station at Columbus. It is now parked on the campus of Ohio State University and has been renamed the Keramos.

Laboratory equipment is to be installed after which it is likely that the car will be used in connection with certain coöperations that are now underway but which have been somewhat handicapped due to inadequate laboratory facilities in the field and living quarters for the investigators.

Fellowship Men The following men are candidates for degrees at Ohio State University after having finished their thesis investigation in the Bureau: Mr. Leonard F. Sheerar, M.A., and Mr. A. Ernest MacGee, Ph.D.

These fellowship investigations are published each year as bulletins by the Ohio State Engineering Experiment Station in coöperation with the Bureau of Mines.

Mr. MacGee will remain with the Bureau to take up work as a coöperative research fellow employed by the Ceramic Research Association. Mr. Sheerar will go with the Robinson Clay Products Company at Dover, Ohio.

Mr. MacGee, using a new method, has determined the heat necessary to fire various clays and ceramic bodies up to 1050°C. Mr. Sheerar has determined (quantitatively) the effect of oxidizing, neutral, and reducing atmospheres upon the deformation under load of refractories containing varying percentages of iron. The effect of the method of manufacture was also included in the tests.

SOCIETY OF GLASS TECHNOLOGY MEETING

At the Annual General Meeting of this Society held in Sheffield on April 22, S. C. Halse was succeeded as President by T. C. Moorshead. To fill vacancies in the Council the following were elected: As Vice-Presidents, W. Butterworth and J. H. Davidson; as ordinary members of Council, Messrs. B. P. Dudding, E. A. Hailwood, H. J. C. Johnston, E. Meigh and G. Simpson. Councillor J. Connolly was reëlected General Treasurer, and W. M. Clark, American Treasurer. W. E. S. Turner was appointed Honorary Secretary and C. S. Davey and Dennis Wood were elected Auditors. The retiring President, S. C. Halse, took as the subject of his Presidential address "The Present State of the British Glass Industry." He pointed out that in certain important branches of the industry the unemployment returns provided no index to the relative state of the industry now and prior to the War. The wholesale introduction of automatic machinery had considerably reduced the number of men employed while the production was simultaneously greatly increased.

At the Ordinary General Meeting which followed the Annual General Meeting, the Society departed from its usual practice of having a series of technical papers. Instead, W. E. S. Turner, at the invitation of the Council, delivered a popular illustrated lecture on "Glass as an Instrument of Human Progress." Prof. Turner dealt with his subject in two main sections, namely, the place of glass in extending man's mental horizon and the use of glass in providing protection, comforts and luxury. In the first section he dealt with the vast extent of knowledge gained through the application of the microscope, telescope, spectroscope, ultramicroscope, camera and chemical apparatus. The second part dealt with the use of heating and illuminating glass and sheet glass for

many purposes and included reference to special spectacle glasses and F. E. Lamplough's new "Vita Glass" for transmitting ultra-violet light and to its use in hospitals, etc. Reference was also made to the preëminent position occupied at present by British-made optical glass.

A RESOLUTION PASSED AT AMERICAN CONSTRUCTION COUNCIL'S CONFERENCE ON THE ELIMINATION OF CONSTRUCTION PEAKS AND DEPRESSIONS, NEW YORK, MAY 9th, 1925

RESOLVED: It is the sense of this conference that the elimination of construction peaks and depressions can be accomplished only by the education of the public and this education can be brought about only by the united effort of all those interested in and affected by greater stability of the construction industry—owners, manufacturers and distributors of materials, transportation agencies and public officials as well as those who have to do with the initiation and prosecution of construction operations.

Therefore be it further resolved that it is the sense of this conference that a general coördinating committee, to be appointed jointly by the American Construction Council and the railways of the country and to include representatives of appropriate bodies within the industry, be organized in order that the publicity of these associations and agencies can be coördinated and unified in a general campaign of publicity for the country as a whole.

CALENDAR OF CONVENTIONS

Organization	Date	Place
Am. Assn. Advancement of Science	Dec. 28–Jan. 2	Kansas City, Mo.
Am. Assn. of Flint and Lime Glass Mfrs.	July, 1925	Atlantic City, N. J.
AMERICAN CERAMIC SOCIETY		
(Annual Meeting)	Feb. 8–13, 1926	Atlanta, Ga.
(Summer Meeting)	July 4–11, 1925	Toronto, Canada
(Fall Meeting)	Oct. 1, 1925	New York City
Am. Electrochemical Society	Sept. 24–26, 1925	Chattanooga, Tenn.
Am. Engineering Council	Jan., 1926	
Am. Foundrymen's Association	Oct. 5–9, 1925	Syracuse, N. Y.
Am. Gas Association	Oct. 12–16, 1925	Atlantic City, N. J.
Am. Inst. of Chemical Engineers	June 22–25, 1925	Providence, R. I.
	July 13–16, 1925	Leeds, England
Am. Inst. of Min. and Met. Engineers	Aug. 31–Sept. 5, 1925	Salt Lake City, Utah
Coal Mining Institute of America	Dec. 9–11, 1925	Pittsburgh, Pa.
Am. Soc. of Mechanical Engineers		
(Annual Meeting)	Nov. 30–Dec. 3	New York City
(Pacific Coast Regional Meeting)	June 22–25, 1925	Portland, Ore.
Am. Soc. for Testing Materials	June 22–26, 1925	Atlantic City, N. J.
Am. Zinc Institute	April 27–28, 1925	St. Louis, Mo.
Assn. Iron and Steel Elec. Engineers	Sept., 1925	Philadelphia, Pa.
Chemical Equipment Exposition	June 22–27, 1925	Providence, R. I.
Common Brick Manufacturers Assn.	Feb., 1925	

Organization	Date	Place
Institution of Chemical Engineers	July 13–16, 1925	Leeds, England
Manufacturing Chemists' Association	June, 1925	New York City
Mining and Met. Society of America	Jan. 12, 1925	New York City
Natl. Association of Manufacturers	Oct. 26–28, 1925	St. Louis, Mo.
Natl. Chemical Equipment Assn.	June 22–27, 1925	Providence, R. I.
Natl. Exposition of Power and Mechanical Engineers	Nov. 30–Dec. 5	New York City
Natl. Exposition of Chem. Industries	Sept. 28–Oct. 3	New York City
Natl. Ornamental Glass Mfrs. Assn.	June 4, 1925	Pittsburgh, Pa.
Natl. Paving Brick Mfrs. Assn.	Jan., 1926	
Natl. Safety Council	Sept. 28–Oct. 2	Cleveland, O.
New Jersey Clay Workers Assn.	June, 1925	Trenton, N. J.
Sand-Lime Brick Assn.	Feb. 9–15, 1926	New Orleans, La.
Sheet Metal Ware Assn.	June, 1925	Cincinnati, O.
Soc. of Chem. Industry	July 13–16, 1925	Leeds, England
Natl. Society for Vocational Education	Dec. 3–5, 1925	Cleveland, Ohio
Natl. Exposition of Coal Mining Machinery	Dec. 2–5, 1925	Cincinnati, O.

BULLETIN

of the

American Ceramic Society

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

Vol. 4 July, 1925 No. 7

EDITORIALS

ARE YOU A MORON?

It is not possible to develop vision and productive thought habits in morons. Morons are incapable because of mental laziness and want of judgment. Morons are not idiots; they simply lack the capacity to think beyond the thing immediately in hand. They often have excellent memories and can creditably do routine things. If perchance a moron has met all the technical requirements for admission into an advanced school and met the technical requirements for a collegiate degree he will still be a moron incapable of origination and be wholly without vision of the possible use of the information he has. His only thought habits are those of registration without power of assimilation and constructive origination. He is without capacity to make application. He is too lazy mentally to analyze, formulate and to conceive. He might trace very creditably but never would he be a designer. He could not vision the working relations and assemblage of parts.

Altogether too many morons and near morons get through college and too many, through lack of interest or because of being misfits in their chosen vocation, slip into moron thought habits. It is a struggle not to degenerate into a moron.

It is only by continued practice that any of us obtain and hold ability to think constructively along a particular line. There is a "loss of hold,"

cunningness and inspiration if for very long one discontinues constructive thinking. An expert is one who is actively and all the while studying and conceiving on a single task, and the fellow is a rare genius who can produce to his possible maximum on several tasks requiring distinctly different character of basic facts, thought procedures and objectives. Specialization is necessary to obtain maximum productiveness. The further scattered and the less definite in thought, the nearer like a moron one will grow to be.

THE STUDENT IN "SCHOOL OF HARD KNOCKS"

One is always impressed with the amount of accurate technical information and ability of those who have worked their way into foremen and managerial positions with no educational training other than that obtained in grammar school supplemented by personal effort and by exchange with their fellows. Many there are from the "school of hard knocks" whose judgment and ability to accomplish gives them a ranking in technical and scientific societies along with those who have had collegiate training.

Josiah Wedgwood was taken from school when only nine years of age and apprenticed to his brother. He was a thrower of unusual skill at eleven years of age. Although made a cripple at eleven by smallpox that left an affected knee, he continued his shop apprenticeship until he was of age. He was the inventor of Queens ware, the Jasper ware, and of a white semi-porcelain. He was the first to operate the potter's wheel by power. He invented a shrinkage gage to measure heat treatment. His inventions were to a great extent a gift to the art. He took out but one patent, and that of an unimportant nature. Josiah Wedgwood died at the age of 65, wealthy, honored, a member of several learned societies.

Biographies of men successful industrially are replete with romantic stories of the rise from the lowliest to the most influential positions. All of them won their way by developing their intellects, by mastering the technique of their jobs. Most of the ceramic shops are today managed by men whose training was in the school of hard knocks, not because college trained men are not capable, but because those who have come up through the shop are also capable and greatly outnumber the college men.

Those who rise through the school of hard knocks are handicapped by lack of knowledge of and facility in use of science facts. Their knowledge is limited to things with which they are engaged. They do not have breadth of science vision and are not posted on informational resources. It is only the more persistent and resourceful of the hard knock school fellows who overcome these handicaps.

It is the business of a national organization such as the AMERICAN CERAMIC

SOCIETY to find ways of helping the ceramists in the school of hard knocks, the men in the shops. The need for college trained men is on the increase and will continue, but educational advantages must be given to the fellows in the shop if our ceramic industries are to meet the ever-increasing competition from substitute products. The fellows in the shop have proven their capacity to learn and to accomplish in spite of discouraging handicaps. They could accomplish greater things with better facilities and fewer handicaps. It will pay the employer to provide educational facilities for his men and it will pay the employed to seek every opportunity to learn what he can of the fundamental sciences and their application to the production of ceramic ware.

Dean Everett W. Lord of Boston University, College of Business Administration, has compiled data on the actual money value of higher education. In a lifetime of sixty years Dean Everett's figures show that the average high school graduate will earn $33,000 more than the average untrained man, and that the average college graduate will earn $72,000 more than the average high school graduate. This gives a line on the cash value of education.

Statistics of Ohio show that 90 per cent of the young people go to work rather than to high school and that 85 per cent enter employment directly from the high schools. The state and city are willing to give these young folks an education but home necessities prevent. The federal and most of the state governments have made financial provision for educational facilities for the employed and in many states they have vocational schools. The Committee on Education of this SOCIETY is working out suggestive plans whereby those who have the grit and ability to make headway in the school of hard knocks may do so with fewer handicaps. The ceramic industries will be greatly benefited when ceramic educational facilities are thus made more general.

PAPERS AND DISCUSSIONS

THE EARLY STAGES OF THE SCIENCE OF CERAMICS IN AMERICA[1]

By Karl Langenbeck

ABSTRACT

Metallurgical operations and growth of white pottery and tile manufacture stimulated search and analyses of desired clays, by state and national departments, after the Civil War. A chemical relation between composition of pottery bodies and glazes was not surmised in English-speaking countries, until projected by the writer. Finding the idea in operation in current work of Seger, his methods of investigation were applied to American raw materials and ceramic processes during ten years, without followers in any other country but Germany. Native clay resources, white vitreous ware, standardization of production and control were developed independently, and introduced commercially.

Growth of the large body of ceramic engineers, obligated by immediate demands for technical results, has prevented true scientific study, of common ceramic phenomena, under known laws of modern physical chemistry. Research is entirely empirical, and hand-books of constants, available to engineers in other fields, are still impossible. To this need of the profession all should now make systematic contribution.

The geological survey of New Jersey for 1874 records that within ten years twelve potteries had been established in Trenton employing 1000 men and 1000 women and boys, turning out $1,500,000 worth of product, in common white earthenware and ironstone china.

This economic interest led geologists in different states to investigate promising clay deposits chemically. Dr. Cooke's "Report on Clays," published in 1878, was followed elsewhere.

Julius Koch, in 1856, believed he had found 1.4% zirconia in New Jersey clay. Dr. Cooke's chemist, Bogardus, now found it to be titanium oxide.

Fire tests of refractory clays were begun by exposing tetrahedra $^7/_8$ inch on the edges, in crucible-steel pots, for one heat of four hours, finding that "some clays were partially fused, others sharp and true, as at the outset."

The refining of white firing New Jersey clay was begun by George Such, at South Amboy.

Interest in refractory clays seems to have started some correspondence with Dr. Bischof in Wiesbaden. Analyses of foreign clays were collected and reported. But when I began work in 1884, neither official chemists nor commercial analysts seemed to have thought of any chemical connection between glazes and the clays upon which they were used.

This connection seemed to me fundamental, but it was not mooted in any publication that I could get in French or English. I found the idea

[1] Presented at the Annual Meeting, American Ceramic Society, Columbus, Ohio, Feb., 1925. (General Session.)

already conceived and applied by Hermann A. Seger in his periodical, *Tonindustrie Zeitung.* I saw at once that application of the scientific method to the "black art" of pottery was no longer a chimera.

The problems that confronted me were: (1) To make myself a practical potter, learn the craftsman's terms for observed phenomena and correlate the conditions of their occurrence.

(2) Figure the chemical formulas of the glazes used and others recommended.

(3) Analyze the commercial raw materials for impurities, deviat on from type, etc.

(4) Ultimate and approximate analyses of commercial clays and comparative trials of the same with synthetic reconstructions, in their relation to bearing the same glaze.

(5) The function of alumina in pottery glazes and its limitations.

(6) Kiln pyrometry.

Coincident with these, and generally taking precedence, were the innumerable immediate plant problems, which take up the time of most of you and had to be more or less satisfactorily solved without guidance.

Some technical results were achieved, which are of general interest because they led to the development of natural resources, improved general manufacture, by showing what could be done and stimulated later research. Among these were:

(*a*) Discovery and commercial introduction of quaternary ball clay in western Kentucky, of the English type.

(*b*) Introduction of residual kaolin from North Carolina, as a corrective of warpage and dunting.

(*c*) Introduction and manufacture of Seger cones from domestic material.

(*d*) Introduction of vitreous floor tile, fired at the same temperature as the glaze flashed or "smeared" English and American tile, solely used at the time. This application of course made vitreous electrical porcelain and hotel china easy, practical achievements.

(*e*) Started the "milled molding-sand" industry.

(*f*) Made the first glazes with crystalline separations.

Ten years, with compulsory interruptions in pharmacy and other branches of technical chemistry, were spent in ceramic work, before I felt satisfied that publication of the information gathered was worth while. In 1894, I published two articles on the domestic pottery industry in the *Journal of the American Chemical Society,* and "The Chemistry of Pottery" a year later.

This reticence was not due to any spirit of professional obscurantism, as many experienced who saw me personally and whom I told and showed freely all they were interested in, without violating professional duty to my employers. I found such communication intelligent self-interest, because it

constantly brought me new viewpoints. This is now, of course, a commonplace and the very *raison d'etre* of our AMERICAN CERAMIC SOCIETY. But, then, my interlocutors found it unusual.

However, publication did not seem to me really fruitful, until one's own experience was sufficiently rounded out, with example and precept to enable others to set to work with something concrete to be done.

Faith in biding my time was of course more than justified, by its falling apt with a need in the University's ceramic school.

There were several very pressing reasons, both personal and professional, which kept me aloof for years from the new movement in ceramic endeavor, which would justify a presumption of lack of liberality and interest on my part. This was not the case. I have been in hearty sympathy with what you have done and my studies, during the interval, were directed not only to following and applying the observations recorded in the *Transactions* and *Journal*, but seeking to clarify them, by new angles from work in other fields.

My interest is scientific rather than technical. I have felt the need of arriving at clarity, above all things, in a concept of our fundamental problem, the behavior and reactions of the clay-water-electrolyte systems. During the past year, I arranged with the Bureau of Standards to put to experimental proof the view-points I have developed.

This brings me to the third point of Dean Hitchcock's invitation, to give some "inspiration to build greater for the future."

What has been accomplished in these thirty years?

(1) Great progress in mechanical engineering, factory-planning, rational economic drying and firing.

(2) Scientific advance in the knowledge of heat reactions.

(3) An adequate technique of empirical experiment, which enabled the ceramic engineer to devise and further pressing demands for enamels, glass, glazes, pottery bodies, cements and corrective agencies. He has so far justified the demands of industry, that our training schools can scarcely meet the growing need for his services.

What does the ceramic engineer lack that every engineer in other lines is equipped with? A pocket-book of data and tables, from which he can calculate the probabilities of the work before him.

From the point of view of chemical engineering, the ceramist lacks the fundamental constants, which in other fields are justifying the purpose of the scientific method, namely, forecasting the future under different conditions.

As a chemist he has not gotten beyond stoichiometry. Intelligent coordination of innumerable observations, recorded in the ceramic journals under the laws discovered by Berthollet, Clausius, Willard Gibbs, Pfeffer, van't Hoff, Arrhenius, Ostwald, etc., have not been made. This is because of the justifiable reason that the engineer and also the hard-pressed

teacher are seldom able to work at unraveling their interlocking details, in a way to which a Faraday, Gay-Lussac or Regnault gave of his time.

But this will have to be done, for the chemistry of clays is not the chemistry of constant proportions. This is only a correlative. The proof of this is the definite rejection of Seger's proximate analysis of clay. Yet a proximate analysis of clay that is not chimerical is absolutely needed.

We have practically dropped clay analysis, because the time-consuming ultimate analysis tells us less than a simple firing test, just as the ultimate analysis of drugs and foodstuffs is valueless. But their division into sugar, starch, alkaloids, fixed and essential oil, resin, extractive matter, fiber and ash is practiced daily, for it is indispensable.

I have reason for assurance that a proximate analysis of clays and other minerals based on modern physical chemistry is practicable and that its technique will prove to be the basis of much more fruitful methods of direct practical trials.

What is clay, for our purposes?

Primarily it is a mixture of microscopic granules, crudely comparable to a concrete aggregate of boulders, pebbles, sand and cement, subject to the laws of piling and flow under pressure, depending upon relative proportions.

These conditions are modified by surface lubrication. The lubricants, or colloid, vary from degrees of adhesiveness toward degrees of resilience, that is, clays shade from stickiness through plasticity to being "punky."

Suspended in water, the fall of the particles is subject to an essential modification of Stokes' law, namely, through the viscosity of the colloid-water system and the surface attraction of the granules for the colloid.

Electrolytes in the system, whether native to the clay, introduced with the natural water or added for manufacturing purposes, act as suspensoids or precipitants by their degree of ionization.

The hydrogen-ion coefficient is a tool for determining the mass action of the weak clay acids, in disrupting the chemical bonds of salts.

In short, the vital chemistry of clays and the minerals used with them, is that which impressed Berthollet in the formation of soda from salt, when on Napoleon's expedition to Egypt, 125 years ago. It is the principle of mass action, which in other relations Solvay applied in his ammonia-soda process and van't Hoff in the separation of the Stassfurt potash salts.

Interacting with this is the Phase Rule of Gibbs, the kinetic theory of Clausius and Maxwell and the mechanisms of flow and fall.

If there is vital truth in this viewpoint, the extensive accurate investigations which it involves are either a discouragement or an inspiration. If it is an inspiration to us, as technical men, the immediate problem is, how shall we apportion the great labor that confronts us, so that we may all share it effectively?

WASHINGTON, D. C.

THE USE OF CLAY PRODUCTS IN MODERN HOMES[1]

By R. B. Keeler

ABSTRACT

An article concentrating attention on the varied uses of clay products in the home of today.

The artistic use as well as the indestructibility of clay products is well known today, and yet we seldom take advantage of these facts in the construction of our modern dwellings.

Past history tells us how clay products have been utilized, first in the tablets of the Egyptians, later in Roman temples, and finally decorating the greatest buildings in Europe.

The principal object of this article is to show the use of these materials as applied to our modern dwelling architecture. Clay products in general bring to mind extreme cleanliness, durability, fire resistant qualities, color harmony and unlimited decorative possibilities.

Fig. 1.

The Spanish specialized in tile several centuries ago, and notably brilliant effects have been wrought by them in colored tiles. The appreciation of this material manifested itself in splendid structures of such as the Alhambra and the Granada.

The modern householder, however, considers his home as of first importance, and the result is that everyone these days thinks more or less of those beautifying touches, which make the home more than a mere shelter.

Beauty and sanitation in the home never before commanded the attention they do today. The comforts and leisure of our up-to-date housewife are determined by the use of materials and conveniences that lessen the burden of housework. Clay products furnish such a material.

In general we might say that the construction of this type of dwelling is

[1] Recd. April 17, 1925.

practically indestructible, not subject to wear, needs very little if any upkeep, is fire-proof, warm in winter and cool in summer, and in fact far more desirable as a home than any other materials now procurable on the market. At this present day and age, however, we seldom find clay products used to any great extent in moderately priced dwellings, owing to the fact that architects and contractors are rather reluctant to work with materials which they are not thoroughly conversant with as to price or decorative possibilities. It is evident, however, that all the manufacturers of clay products should endeavor to bring before the eye of the public typical examples of what may be done along these lines, and this article is intended to show the actual application of these materials to our everyday home.

FIG. 2.

We give in the following illustrations a typical early California style home, describing in detail the general construction and decoration, referring in particular to the use of hollow tile walls, tile and terra cotta decorations.

Description of Photographs

Figure 1 shows the front elevation of the dwelling. The exterior walls of this dwelling are 12 inches in thickness. The lintels are made of cast concrete 12 inches high, and reinforced with iron bars. The roof is covered

with clay roofing tile in various shades of red and brown. The window mullions are covered with twisted terra cotta columns; the stud bolt heads in the lintel are covered with tile rosettes, the front steps are made of vitrified brown rustic tile with a 2-inch overhang on the front, and the risers are made from decorative Spanish tile. Note the use of the terra cotta urn on the front steps.

Figure 2 is a close up view of the front entrance showing in detail the rustic tile steps, Hispano-Moresque risers, and this detail shows more clearly the tile quoins surrounding the doorway.

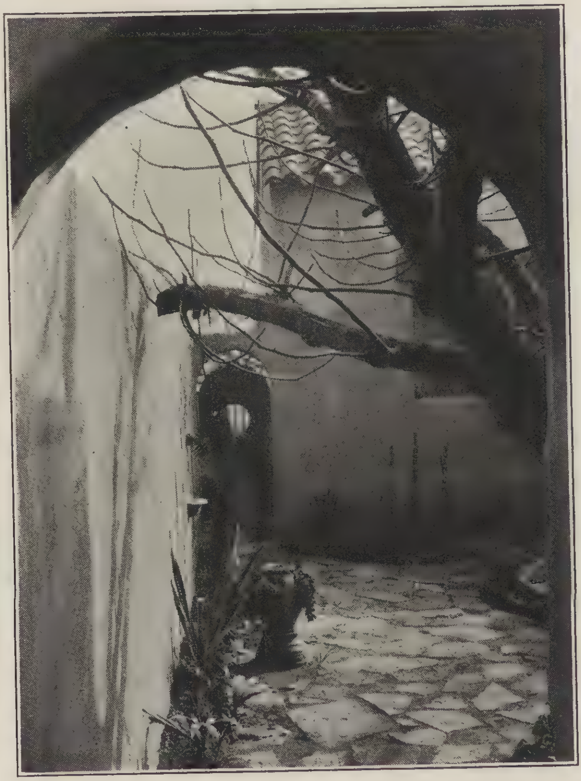


Fig. 3.

Figure 3. Entering the patio from the stepping stones along edge of the house we catch a glimpse of the side of the wall fountain, the small child's head protruding from the wall, dropping water into the bird's bath below, and in the immediate foreground the strawberry jar, having little cups along the sides which become the nests of strawberry plants.

Figure 4 shows the close up detail of the tile work surrounding the wall

fountain, while down below a large clay frog may be seen looking toward the fountain.

Figure 5 shows the circular pool in the patio, displaying on its border the varied use of the Moorish tile, as well as the four decorative frogs. These frogs are piped with small copper water pipes, and controlled with a valve, which allows them to spout water into the pond.

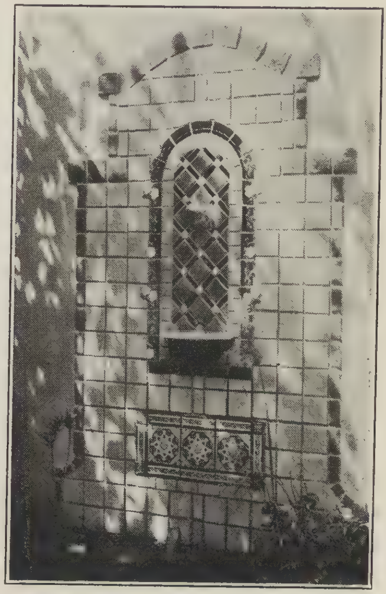


Fig. 4.

Figure 6 shows the use of tile panels below the living room windows. These tile are of decided Arabic design and portray the great interest that materials of this kind lend to various portions of a dwelling. At the upper right hand corner of this picture is shown one of the roof spouts, which is also a clay product of considerable value to the home, being ornamental as well as useful.

Figure 7 shows again another window decorated with very flowery Mohammedan tile, and emphasizing the true value of such decoration. Below the window panel may be seen tile ventilators.

Figure 8. Entering the front door we note the use of Hispano-Moresque tile wainscot copied from the Casa del Greca of Spain, and colored with deep rich vivid colors used by the Moors in the decoration of Spanish homes. In the upper right hand corner may be seen the built-in radio,

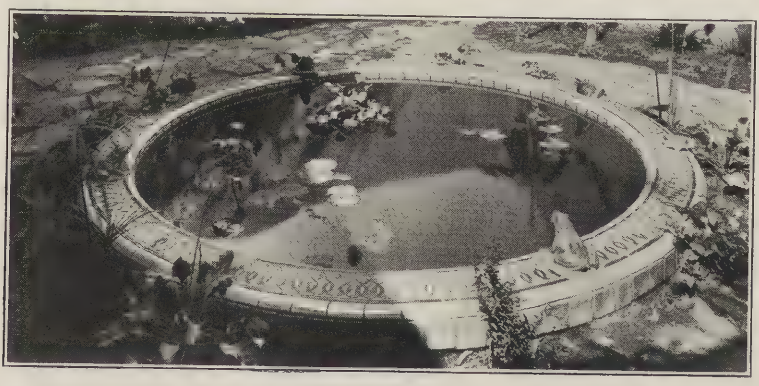


Fig. 5.

Fig. 6.

Fig. 7.

and below, the wooden grille covering up the face of the radio dials, etc. All piping, batteries, etc., are concealed in the wall, and are accessible from a small closet on the rear side. The floor tile as well as the tile skirting the wall are made in soft rich browns dotted here and there with an occasional small tile of black, blue or buff. The size of the tile are varied, creating a general random pattern throughout the room.

Figure 9. Looking down through the living room we see against the wall a mantel of faience terra cotta copied from the very old relics left by the prehistoric Maya tribe in Yucatan and Guatemala, and the figures above the mantel shelf are supporting electric light lamps in imitation of ancient stone lamps. Mica is used in place of glass in the three sides of the lamps. The gas logs are, of course, made from clay products. The rustic tile

hearth may be seen in detail in this picture, as well as the random pattern of the floor tile.

Figure 10. Looking into the library from the living room we note the use of perforated ventilator tile in the bulkheads. The floor is made up of vitrified brown hexagon tile surrounded with a border of 3 x 3 vari-colored tile. The step tread is a very good example of the rustic effect obtained in tile by cutting odd shaped joints. Floors of this kind are particularly interesting when made in various shades of red, buff, and brown, and the durability of this type of floor is very well known, in fact,

FIG. 8.

the life is far greater than that of the home itself, and it is not impractical or impossible to lay such a tile floor directly upon a 3-inch concrete floor, which has previously been laid over the ground. In this house, the living room, library and vestibule floor are laid directly on the ground, thus saving the expense of floor joists, carpenter work, etc., and this constitutes quite an item in the cost of such a building.

Figure 11. Entering the dining room and looking back toward the living room, we see the change in the type of floor tile, and the use of Hispano-Moresque tile on the wainscot or baseboard of the room. Decorative

tile are also in the back wall of the niche above the china closets. Floors of this kind are very easily kept clean, and lessen the work of the housewife.

Figure 12. Entering the corridor from the dining room brings out the more cheerful character of the floor in a portion of the home which is usually very uninteresting. Gray glazed floor tile intermingled with small squares of red are laid in pattern throughout the floor, the border being decorated with flowered inserts. The wainscot around the sides of

Fig. 9.

this hall carries a wistaria design in color, and the plaster of the walls is brought down flush with the surface of the tile. All of this decoration adds a tone of distinction to this portion of the house, which would under ordinary circumstances be very dull. Tile is used only as a base throughout the front bed room, having decorative flowers, leaves and stems, which serve as an ornament for this tile. The plaster of the wall is brought flush

Fig. 10.

with the surface of the tile. The rear bedroom has a gray tile base ornamented with blue flowers, green leaves and brown stems.

Figure 13 shows the use of bright glazed wall tile in the bathroom. The color of these tile is a soft cream with a light tinge of orange throughout. The small flowers interspersed with the larger sections are white with soft turquoise blue background, the center of the flower being yellow. Above we have a border of white flowers, green leaves, and brown stems. The floor is composed of 2-inch square buff ceramic tile surrounded with a border of pink, gray and white.

Fig. 11.

Figure 14 gives a general view of the sleeping porch, and the red quarry

Fig. 12.

tile floor. Folding beds are seen to the right which are closed during the day and only lowered at night.

Figure 15. Entering the kitchen from the hall we encounter a turquoise blue wall tile trimmed with a frieze of polychrome dots, and with a strip of cream above the base. The floor is composed of 2-inch hexagon tile with appropriate border. There is nothing that adds to the cheerfulness and cleanliness of a house better than glazed tile, and the use of colored glazed tile is fast becoming popular. Colors, after all, are the keynote of interior decorating, and many unusual effects are obtained by the use of the proper colors in the proper rooms.

Figure 16 shows the breakfast room walls just off the kitchen, and in this room the colors deviate from the ordinary, being made up of transparent golden browns blending from light to

Fig. 13.

FIG. 14.

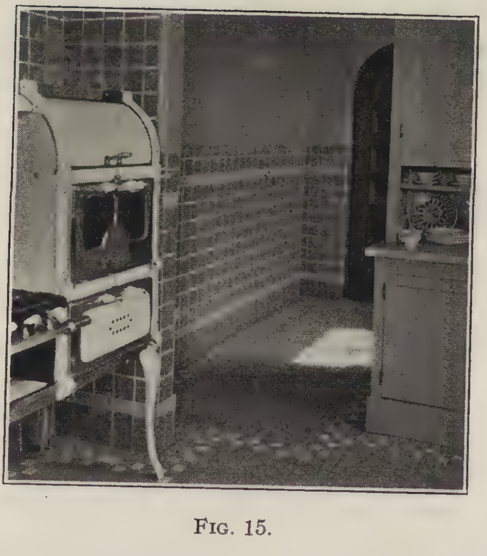


FIG. 15.

dark and laid in random sizes, and in scattered shades along the wall. The floor is made up in the same colors but in matt glaze. The effect on entering a room of this kind is very striking.

In conclusion, we might say that the construction of this type of dwelling is after all the most economical. The first costs, perhaps, are a little greater than that of wood. On the other hand, the insurance, painting, wear and repair on the average dwelling soon mounts up into considerable expense, and houses of this type are really improved by age, even in 10 or 20 years they stand as a monument to their materials.

Fig. 16.

The door and window casing are limited to very small wood sections, in fact just enough wood is used to fasten the casing, and to be consistent with strength. The window frames are all metal. The exterior woodwork is not painted, but is simply burnt in a fire or with a gasoline torch, being finally brushed off with a wire brush. The interior woodwork is treated the same way.

The exterior walls are plastered with one coat of waterproof cement and sand in proportion of about one to three. The interior walls are also plastered in the same proportion, hollow partition tile being used between the walls as well as in the exterior walls. The interior walls are finally painted and need no other finish. The outside walls may be painted with whitewash brush and cement paint, or else left in their original color.

May we not consider these everlasting materials more seriously in the building of our homes, and in perpetuating the ideas which soon become memory in other materials.

California Clay Products Co.
Los Angeles, Calif.

CONVENTIONAL VERSUS NATURALISTIC DESIGN[1]

By Mary Lanier Yancey

ABSTRACT

Growth from the naturalistic to the conventional type of design is the resultant of certain definite causes. The way for this growth among the people has been made smooth by the change from factory production to individual production in the crafts, and by more widely spread art education. Naturalistic design is based on imitation of natural forms and is enjoyed by the average man because of its likeness to life. The result of this satisfaction is a loss of interest and the need for a conventional treatment. Conventionalism is an adaption of natural forms through the addition of the designer's personality. It is interpretation as opposed to fact. Conventionalism is sometimes misrepresented as being a kind of cleverness and inventiveness, and as a way of hiding bad drawing. Correctly understood, however, conventionalism is construction, not invention, and requires more skill in drawing than does mere representation.

Introduction

After a thorough training in design at the Newcomb School of Art for four years and a continued interest in and application of it in teaching for two years, my taste has changed over from the naturalistic type of design to the conventional. I assume that this is a normal growth and the result of certain causes which are believed to be obscure to all but artists but which can be clearly analyzed and defined.

The field of pottery decoration is among the clearest of mirrors reflecting the tendencies of public taste in design. The turning away from the strictly commercial product, from production in great quantities which was necessarily mechanical and neglectful of design, to the artistic pottery given us by the trained and gifted craftsman was a change comparatively recent. It was a step in the right direction and is responsible for much beauty and much appreciation of design as applied to the crafts. At the present time there is another general change taking place, *i. e.*, the demand of the public now more widely educated in art appreciation, for a different type of design. It is the turning from the essentially pictorial to the representational and interpretive, from the naturalistic to the conventional.

Naturalistic Design Like Life

Naturalistic design is arrangement presented in a form as much like nature as it is possible for art to be. It is basically imitative of natural forms. It is the kind of design most suited to the first training in art appreciation because it shows to the disinterested man something with which he is familiar and thereby pleases him. It gets across. It satisfies his expectations because of its verisimilitude, which is the standard by which he judges. It is design spoken in a fashion which he cannot help but

[1] Presented at the Annual Meeting, American Ceramic Society, Columbus, Ohio. Feb., 1925. (Art Division.)

understand because it is all around him. It is easy to be lifelike and easy to enjoy what is lifelike. In naturalistic design there is no mental effort incited, and as there is failure to exact the highest emotional and intellectual activity on the part of the artist, there is a proportionate failure on the part of his audience.

Over-Satisfaction from Naturalistic Design

Imitative art soon ceases to be interesting for the very reason that it does satisfy and quickly disgusts. It surfeits the appetite, becoming too much an exhibition of cleverness, of sweetness and sophistication, just as striving for too accurate a conception and too much realism in art has always resulted in decadence.

Conventionalism the Outcome

The result of this over-satisfaction is a reaching out for the imaginative presentation. A wise conventionalism is the proper answer to the need. In conventional design the artist endeavors to create form, based upon suggestions from nature, by adapting nature to his own will, by adding to it his own personality. He calls forth in his audience the same set of mental reactions upon which he constructed his design, and this element adds an intellectual pleasure to the aesthetic one. Conventional design is a pique to the interest as against the over-satisfaction of it.

Conventional Design Interpretive

Conventional design is a step beyond naturalistic because the one is interpretation whereas the other is a reproduction in an arranged form. An interpretation heightens the quality, refines the conception and approaches nearer to pure form than can a statement of fact, however, much adorned. Just as art surpasses photography by getting rid of that commonplaceness which is almost vulgarity, so conventionalism is a translation, a development and refinement of quality.

Misapprehensions of Conventionalism

There is a danger of conventionalism being used as a term for mere inventiveness. A total disregard for natural forms and growth and the resulting coldness and lack of interest are often attributed to conventional treatment. Worst of all is the despicable ruse of using the word conventional as a cloak to cover a lack of skill in draughtsmanship. Such libels upon the term have caused the school of design to become unpopular in many instances and have created a general misapprehension.

Correction of Misapprehension

In reality conventional design is the result of construction as opposed to invention. The artist builds upon his knowledge which is the greatest prerequisite for good designing. Instead of disregarding natural forms and growth he emphasizes the important features of them, eliminating those which are unimportant and accidental. Henry R. Poore says in "The Conception of Art," "Art is the expression of the essential character of a subject." Conventional design by minimizing detail enhances the essential character of the subject used for design. Far from excusing bad drawing, conventional treatment requires more skill than any other because joy in pure beauty of line and proportion must fill the gap occupied in naturalistic treatment by the pleasure derived from associations.

Iowa State College
Ames, Iowa

A METHOD FOR DETERMINING THE LIFE OF A SAGGER[1]

By Robert F. Sherwood

ABSTRACT

A method for determining the average life of a sagger over the period of a year is given as an aid in determining costs. Inventories are taken at the beginning and at the end of the year, and a record is kept of the saggers made. The average number of saggers fired in a kiln is determined and from these figures the percentage loss of life of each sagger per fire is determined, as well as the number of fires per sagger.

The sagger breakage problem is a most important problem in the great majority of plants using saggers. In use, a sagger is broken either during the firing or during the handling of the saggers when the kiln is drawn. If the department that has charge of drawing the kilns has a small labor turnover, the sagger breakage will be much less than if the labor turnover is high in that department. The tunnel kiln has done much to cut down sagger losses, but for those plants using periodic kilns the life of a sagger is an important item in sagger costs.

To determine the number of fires a sagger will withstand before it breaks may be done in a number of different ways. Undoubtedly the most common method for determining the life of a sagger is to mark a number of saggers, perhaps a bung or two, and keep them separate from the other saggers in the kiln. From the number of fires which these saggers withstand is determined the life of a sagger. This may be done several times during a year or it may be done only once. This method of determining the life of a sagger is always more or less unsatisfactory because the men drawing the kiln see the marks on the saggers, know what is going on, and consequently handle the marked saggers very carefully.

---

[1] Presented at the Annual Meeting, American Ceramic Society, Columbus, Ohio, Feb., 1925. (White Wares Division.)

One of the best methods for determining the life of a sagger is a method which takes into consideration the number of saggers made and the number broken during a long period of time, probably a year. Perhaps to some, this method may seem impracticable, but in the majority of cases the information gained will be well worth the time and the effort expended.

If the period of time under consideration be taken as one year, an inventory must be taken of the saggers on hand at the beginning of the year and at the end of the year, and a record kept of the saggers made during the year. The average number of saggers placed in each different size kiln must also be determined. A method that has been found quite satisfactory in determining the number of saggers in a kiln is to take an inventory of the saggers as the kiln is being drawn. If this inventory be taken several times during the year for each size of kiln a fair average may be obtained of the number of saggers placed in each kiln.

The formula used for determining the percentage loss of life of each sagger per fire is as follows:

$$\frac{\text{Total sagger breakage}}{\text{Total number of sagger fires, or total sagger placed of each sagger per fire}} \times 100 = \text{Percentage loss of life}$$

Taking 100% as the total percentage life of a sagger, and dividing this total percentage by the percentage loss of life of a sagger per fire will give the average number of fires a sagger will last.

The total sagger breakage may be found by adding the saggers inventoried January 1 and the saggers made during the year and then subtracting from this total the saggers inventoried December 31.

The total number of sagger fires for each kiln may be found by multiplying the number of times that kiln is fired by the average number of saggers contained in that kiln. Then by adding the total sagger fires for each kiln, the total number of saggers fired for the year will be obtained.

Having thus found the total sagger breakage and the total number of sagger fires, the above formula may be used to determine the percentage loss of life for each fire for each sagger. And from this percentage loss of life of a sagger per fire, the actual life of a sagger may be obtained.

Following is an example of this method in actual use:

Kiln No.	No. of times fired	Average sagger content
1	20	1200
2	30	1000
3	40	1300
4	15	900
(*a*) Total saggers inventoried Jan. 1		15,000
(*b*) Total saggers made during year		10,000
(*c*) Total saggers inventoried Dec. 31		15,000

$$(a + b) - c = d$$

(*d*) Total saggers broken during the year 10,000

	Total sagger fires		
1	20 × 1200	=	24,000
2	30 × 1000	=	30,000
3	40 × 1300	=	52,000
4	15 × 900	=	13,500

(*e*) Total number of sagger fires for the year 119,500

$$(d \div e) \times 100 = f$$

(*f*) Percentage loss of life of each sagger per fire 8.36%
(*g*) Percentage total life of each sagger 100%

$$g \div f = h$$

(*h*) Number of fires per sagger 11.9

By this method of arriving at the number of fires a sagger will last, or the number of fires per sagger, the figure obtained is the average life of a sagger for the year, and is an accurate criterion as to the life of a sagger in actual use.

For those plants whose kilns are all the same size, and will therefore hold the same number of saggers, the method used for determining the life of a sagger is practically the same and somewhat simpler. In this case the average number of saggers contained in each kiln will be the same for all kilns, and this average may be obtained from any or all of the kilns.

The same inventories should be taken as before, at the beginning of the year and at the end of the year, and of course a record kept of the saggers made during the year. The total number of saggers broken during the year can be obtained in the same manner.

Since all the kilns are the same size in this case, an average number of saggers broken per kiln may be obtained by dividing the total number of saggers broken during the year by the number of kilns fired during the year. Considerable use may be made of this figure denoting the number of saggers broken per kiln. After the first year when this average is obtained, an inventory can be taken of the broken saggers in several kilns as they are being drawn, and from this inventory it can readily be determined whether or not the sagger breakage is running above or below the average for the past year.

Having obtained this average number of saggers broken per kiln, the percentage loss of life of each sagger per fire may be had by dividing the average number of saggers broken per kiln by the number of kilns fired. Then since the total percentage life of a sagger is 100%, the life of a sagger is obtained by dividing this 100% life of a sagger by the percentage loss of life of each sagger per fire.

An example of this method in actual practice is as follows:

(*a*)	Total saggers inventoried Jan. 1	4000
(*b*)	Total saggers made during the year	2000
(*c*)	Total saggers inventoried Dec. 31	3000

$$(a + b) - c = d$$

(*d*)	Total saggers broken during the year	3000
(*e*)	Number of kilns fired during the year	150

$$d \div e = f$$

(*f*)	Average number of saggers broken per kiln	30
(*g*)	Average number of saggers placed in a kiln	600

$$(f \div g) \times 100 = h$$

(*h*)	Percentage loss of life for each sagger per fire	5%
(*i*)	Percentage total life of each sagger	100%

$$i \div h = j$$

(*j*)	Number of fires per sagger	20

No account has been taken of those saggers that are broken while drying or broken in any other manner while they are green and never reach the kiln. They are included in the number of saggers made during the year, and therefore are included in the number of saggers broken during the year. In some instances this may tend to bring down the number of fires per sagger, but by including this loss in the sagger breakage for the year a more accurate figure is obtained on the life of a sagger from the time it is made until it is broken than if this breakage were not taken into consideration.

The period of time used to determine the life of a sagger may be changed to suit conditions. Perhaps in some instances a shorter period than a year, three months or six months may be taken. If the cost department can issue these reports on the life of a sagger for each quarter or each six months they would show just how the sagger breakage was running and would undoubtedly be of assistance in bringing down sagger losses.

Ceramic Laboratory
Pass & Seymour, Inc.
Syracuse, N. Y.

ACTIVITIES OF THE SOCIETY

ANNUAL MEETING, ATLANTA, GEORGIA

February 8–13, 1926

Arrangements for the 1926 Annual Meeting, which is to be held in Atlanta, Georgia, are progressing. The local committees are organized and are getting under way. A time schedule for the side trips and plans for entertainments are quite complete.

Dr. Charles H. Herty, President of Synthetic Organic Chemical Manufacturers Association, a native of Georgia and a man of world-wide reputation as an industrial scientist, will give the address of welcome.

The Committee on Education is working up a program for the opening general session on the general subject of ceramic education. The whole subject of ceramic education is of vital interest to the taxpayer and to ceramic manufacturers because of the large sums of money now being expended in support of educational enterprises, and because of the rapidly increasing demand for men with minds trained to use science facts in the solution of industrial problems. Evidence of the very general interest in educational questions is shown by the appointment of committees on education by nearly every ceramic trade association and by the ceramic institutes.

The Divisions are getting under way with their programs. They will have sessions beginning Tuesday morning and closing Thursday noon. The South has ceramic materials, an increasing market and a hustling industrial personnel, and, of course, will be putting forth their very best foot at this Annual Meeting, but these technical sessions by Divisions will be exclusively of broad and fundamental interest as they have been always.

An exhibit of ceramic products, ceramic materials and equipment is being provided for and the interest already evidenced is prophetic of an exhibit even greater and more educational than any which the SOCIETY has heretofore sponsored. These exhibits are managed at cost with profit accruing to none other than the delegates attending the Meeting.

The week of February 8–13 in Atlanta, Georgia with side trips to Macon and through the clay belt promises to be one of great interest. Historically and because of nature's grandeur this part of our country will please and appeal to you. It is different and, as the land and climate are different so are the Southern people a wee bit different, and pleasingly so. The ladies of Atlanta are going to stage a "cut up" evening at the Woman's Club with a varied program of music, dramatics and dancing. The Macon business men have planned a royal welcome at their hotels and country clubs. The clay workers of the Gordon-McIntyre district have an original barbecue in which, by practice, they are adepts unsurpassed. These are suggestive only of the large and varied reception that await our participation but all with due regard to the serious reasons for the delegates attending the technical sessions, viewing the exhibits, visiting the universities, museums and historical parks. A setting for more dignified pleasure, cultural and industrial education is rarely had at any meeting than is being arranged for our next Annual Meeting.

NEW MEMBERS RECEIVED FROM MAY 15 TO JUNE 15

PERSONAL

A. J. Bruce, 173 E. Woodbridge St., Detroit, Mich. President, Bruce Products Corp.

John F. Butler, President, Elgin-Butler Brick and Tile Co., Austin, Texas.

Wilber A. Carter, 8741 Arcadia Ave., Detroit, Mich. Engineer, Research Dept., Detroit Edison Co.

John T. Curry, Manager, Terra Cotta Service Bureau, 307 N. Michigan Ave., Chicago, Ill.

Winfield Eckley, Vice-Pres.-Manager, U. S. Brick Co., Tell City, Ind.

D. R. Ferguson, Jr., Assistant General Manager, Crescent Brick Co., New Cumberland, W. Va.

Walter L. Fitzgerald, Wesley Bldg., 1701 Arch St., Philadelphia, Pa., Eastern Representative, Haws Refractories Co., Johnstown, Pa.

Hermann Hofmeister, Rommerode, Bez-Cassel, Germany. General Manager, Vereinigte Grossalmeroder Thonwerke Act. Ges.

E. M. Jones, Brick Manufacturer, Box 396, Altoona, Pa.

C. Mayhew, 48 Leamington Gardens, Seven Kings, Ilford Essex, Scotland. John G. Stein and Co., Ltd., Bonnybridge.

Ernest Miller, Ashley Villa, New Rd. Bromsgrove, Scotland. John G. Stein & Co., Ltd., Bonnybridge.

Alfred Magill Randolph, P. O. Box 395, Warrenton, Va. Electrical Engineer, Metropolitan-Vickers Electric Co., Ltd., Manchester, England.

J. A. Rumer, 54 N. Parkside Ave., Apt. 1, Chicago, Ill. Chicago Representative, The Ferro Enamel Supply Co.

Hubert Somers, 209 N. Missouri Ave., Atlantic City, N. J. Treasurer, Somers Brick Co.

Paul Stevens, 1703 N. Artesian Ave., Chicago, Ill. Enameler.

CORPORATIONS

The New Martinsville Glass Mfg. Co., W. A. M. Clarke, General Manager and Secretary, New Martinsville, W. Va.

Hydraulic-Press Brick Co., Geo. F. Baker, Secy. and Treas., 705 Olive St., St. Louis, Mo.

Membership Workers' Record

	Personal	Corporation
F. A. Harvey	1	
R. A. Horning	1	1
W. G. Owen	1	
Colonel Alan Stein	2	
A. Silverman		1
F. L. Steinhoff	1	
J. S. Unger	1	
R. A. Weaver	1	
Office	7	
	15	2

PERSONAL NOTES

E. N. Bunting, lately of the Western Electric Co., New York City, is now associated with the National Research Council, Washington, D. C.

Ernest Clark of the American Terra Cotta & Ceramic Co., of Terra Cotta, Ill., has recently moved to Kansas City, Mo., and is associated with the Kansas City Terra Cotta & Faience Co.

C. D. Clawson, of the class of 1925 of Ohio State University, is located at 84 North Ave., Battle Creek, Mich.

Miss Mabel C. Farren of Pittsburgh, Pa., is spending a year at Monmouth, Oregon. She is teaching in the State Normal School.

Ray S. Godard, on Montreal, Canada, has accepted a position with the H. L. Dixon Co., Pittsburgh, Pa.

James T. Keenan has left the Vitrolite Company, Parkersburg, W. Va., and is associated with the B. F. Drakenfeld & Co., Inc., Washington, Pa.

E. K. Koos, formerly associated with the Chelsea China Co., New Cumberland, W. Va., has accepted a position with the Red Wing Union Stoneware Co., Red Wing, Minn.

Morgan D. Lalor formerly of Los Angeles, Calif., has moved to 527 Colvin St., Baltimore, Md.

Charles C. Leigh has moved from Tacony, Pa., to 3400 Longshore St., Philadelphia, Pa.

Frobisher T. Lyttle, of Whiting, Ind., is now living at Monmouth, Ill.

D. P. Ogden is associated with the Ogden Engineering Co., Ottawa, Ill.

Will A. Rhodes has left the Sebring Pottery Co., of Sebring, Ohio, and is working with the Jackson Vitrified China Co., Falls Creek, Pa.

Edwin M. Rupp, of Middletown, Ohio, has moved to 226 W. 47th St., New York City.

H. H. Stephenson has recently resigned as chemist with the American Encaustic Tiling Co., Zanesville, Ohio, and is now employed by the N. Y. Architectural Terra Cotta Co., Long Island City, N. Y.

Alden E. Stilson, formerly employed by the Chicago Fire Brick Co., is now affiliated with the Portsmouth Refractories Co., Portsmouth, Ohio.

Ray T. Stull has moved from Savannah, to 303 Hillyer Ave., Macon, Ga.

C. Forrest Tefft, member of the Board of Trustees of this Society has moved from Watsontown, Pa., to Columbus, Ohio. Mr. Tefft is General Manager of the Claycraft Company plants.

Karl Turk has moved from 116 W. Hamilton Ave., Baltimore, Md. to Riderwood, Md.

B. W. Willson, of Mason City, Iowa, is now living at 5037-A Ridge Ave., St. Louis, Mo.

THE PITTSBURGH LOCAL SECTION MEETING, JUNE 3, 1925[1]

On Wednesday evening, June 3, the Pittsburgh Section of the Society held a ladies' night dinner at the Faculty Club of the University of Pittsburgh.

The guests of the Section were Leon Yeatman and Mr. Fauchon of the French Ceramic Society, and Mr. Duff of the National Paving Brick Association of Cleveland.

Mr. F. W. Donahoe acted as toastmaster. After the dinner, owing to the torrid weather, the meeting adjourned to the spacious porch of the Faculty Club. Here all formality was dispensed with and speeches were transformed into informal discussions. Mr. Yeatman told of his mission to this country in the interest of French vitrified paving brick. A little later he spoke of the reconstruction and rehabilitation of the devastated areas of France. The Section was much interested in his French ideas regarding the working of the Dawes plan.

Dr. E. W. Tillotson voiced the welcome of the American Ceramic Society to the French visitors and regretted that Mr. Yeatman's stay was to be so short.

[1] Foster Robertson, *Secretary.*

SECOND PROGRESS REPORT ON CAST IRON FOR ENAMELING

Bureau of Standards,
Washington, D. C.,
June 9, 1925.

To the Members of the Enamel Division:

You will, no doubt, be pleased to learn that the Cast Iron Research is progressing rapidly at the Bureau of Standards. The work of late has been of such a nature that it has not been necessary to send out castings for enameling.

Our last Progress Report to the Enameling Division of the AMERICAN CERAMIC SOCIETY at Columbus, Ohio, included the results obtained on a number of sample plates cast from northern pig irons claimed to blister on enameling. These castings were distributed to coöperating enamelers and also enameled in our laboratory. Both lots of sample plates were found to blister if enameled above a fairly definite temperature, *i. e.*, about 1290°F.

There are three main possibilities as to the cause of the blisters, as follows: some gas is taken up as such in the blast furnace, due to some difference in operating conditions in northern furnaces. It has been assumed that on remelting once in the cupola the gas is not removed, but it is on repeated melting. Just why this should happen is not clear, because analyses of cast irons for oxygen, hydrogen and nitrogen show no differences between ordinary and remelted irons.

The second possibility is that some element not shown by ordinary analysis might be present in the pig and is in some hidden way responsible for the trouble. Spectroscopic analyses have been made to determine this but no differences that could be considered significant were found.

The third possibility is that the trouble may lie in the presence of graphite on the surface, which is not wholly removed by sand-blasting and which, at a sufficiently high enameling temperature, reacts with the oxides of the enamel to form carbon monoxide, which causes blisters. By remelting, something might happen to change the distribution of graphite so that finally the surface after sand-blasting would be free from graphite.

In view of the possibilities, sample plates were prepared from two northern irons melted once in the electric furnace. The scrap produced was also remelted and cast into sample plates. One northern iron has been remelted in the cupola two times and sample plates cast. The test pieces made by the above methods have been enameled at the Bureau of Standards and the results obtained were promising. It was found that all plates cast from the first melting in the electric furnace blistered, however, not as badly when enameled by the dry process as when enameled by the wet process. Sample plates obtained by remelting the scrap both in the electric furnace and cupola show no blisters when enameled by the dry process and a decided reduction in blistering in the wet process. It appears that remelting the iron several times is quite beneficial in reducing the blistering of the enamel.

Chemical analyses of the cupola and electric furnace melts have been made. Microscopic examination is in progress.

Some of this work is an extension of the original tentative program. Unless other methods of attack appear more promising, the bulk of the original program will be followed, but will be modified as the results of the tests may indicate.

Your Committee on Research has established a research fund to which all interested parties are urged to contribute. Following is the list of contributors to the Cast Iron Research Fund to date:

The American Radiator Co., Buffalo, N. Y.; American Stove Co., St. Louis, Mo.;

The Beckwith Co., Dowagiac, Mich.; Belleville Enameling Works, Belleville, Ill.; Bridge and Beach Mfg. Co., St. Louis, Mo.; Buckwalter Stove Co., Royersford, Pa.; Chicago Hardware Foundry Co., North Chicago, Ill.; Chicago Vitreous Enamel Product Co., Cicero, Ill.; Crane Enamelware Co., Chattanooga, Tenn.; Cribben and Sexton Co., Chicago, Ill.; The Early Foundry Co., Dickson, Pa.; Evansville Enameling Co.; The Floyd-Wells Co., Royersford, Pa.; The Humphreys Manufacturing Co., Mansfield, Ohio; Ingram-Richardson Manufacturing Co., Beaver Falls, Pa.; Iron City Sanitary Manufacturing Co., Pittsburgh, Pa.; Kohler Co., Kohler, Wis.; A. J. Lindemann and Hoverson Co., Milwaukee, Wis.; Malleable Iron Range Co., Beaver Dam, Wis.; The Marietta Hollow-Ware and Enameling Co., Marietta, Pa.; Metal and Thermit Corporation, New York, N. Y.; Moore Brothers Co., Joliet, Ill.; Panghorn Corporation, Hagerstown, Md.; The Pfaudler Co., Elyria, Ohio; The Porcelain Enamel and Manufacturing Co., Baltimore, Md.; George D. Roper Corporation, Rockford, Ill.; Rundle Manufacturing Co., Milwaukee, Wis.; Rehoboth Porcelain Enamel Co., Rehoboth, Mass.; Standard Sanitary Manufacturing Co., Pittsburgh, Pa.; The U. S. Smelting Furnace Co., Belleville, Ill.; The Wehrle Co., Newark, Ohio; Ward Leonard Electric Co., Mount Vernon, N. Y.; Wolff Manufacturing Corporation, Chicago, Ill.; Washington Iron Works, Los Angeles, Calif.

In addition to the financial support furnished by the above, numerous offers of coöperation have also been received. It is impossible for the Committee to accept all of these offers for fear of spreading the work over too large an area. A few have been chosen for some special purpose.

You will receive these reports from time to time as the work progresses and the data becomes available. Your advice, criticisms and suggestions are earnestly solicited.

Very truly yours,

H. G. Wolfram

Secretary, Enamel Division.

By direction of the Research Committee.

NOTES AND NEWS

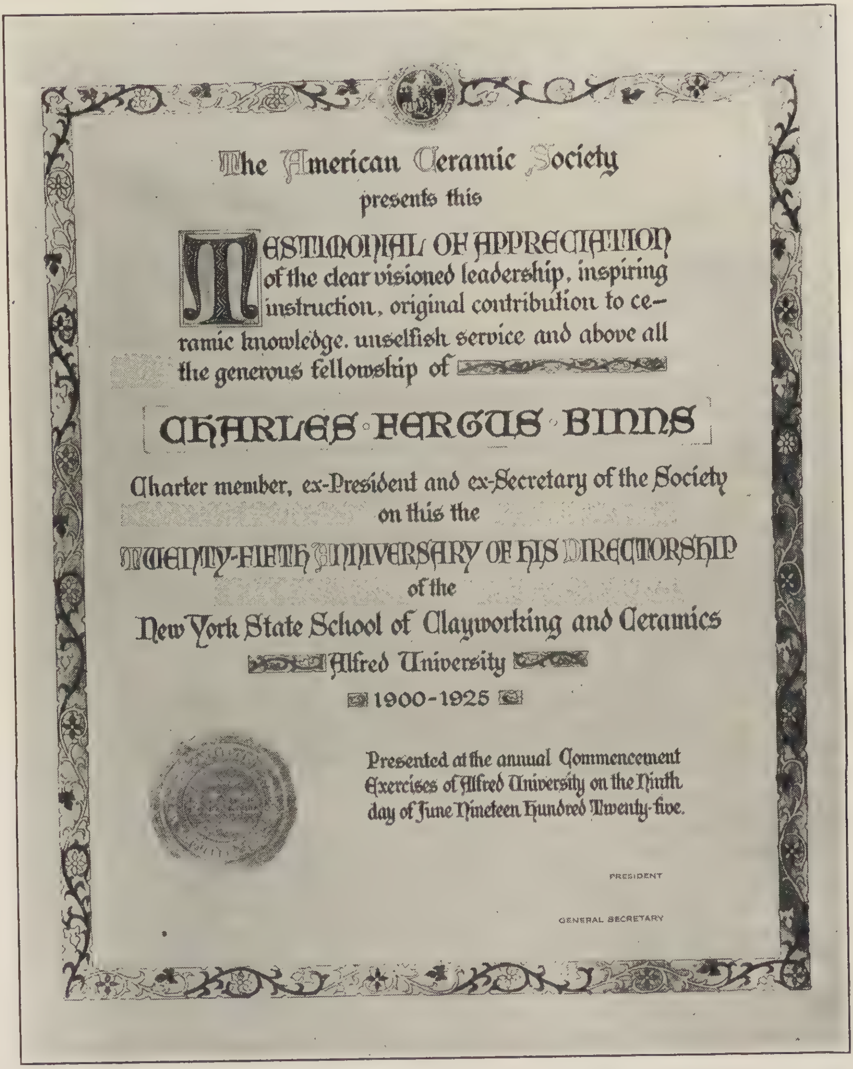
CHARLES FERGUS BINNS, D.SC.

On June 10 at Alfred, N. Y., Charles F. Binns was given the honorary degree of Doctor of Science by his collegiate associates as a token of their estimate of his scientific accomplishments. President E. Ward Tillotson and General Secretary Ross C. Purdy of the American Ceramic Society attended the commencement exercises of Alfred University in testimony of the regard and esteem in which Dr. Binns is held generally by ceramic manufacturers. Prof. A. S. Watts, director of the pioneer collegiate ceramic department, Ohio State University, was there to tell of the high place earned by Dr. Binns in collegiate circles. Several ceramic friends and many of the graduates of the Alfred Ceramic School were present to do honor and to give personal expression of appreciation of the contributions made by Dr. Binns to ceramic technology and art.

The annual commencement week of Alfred University was taken as an opportunity to honor a man who, for twenty-five years, has so directed the New York State School of Clayworking and Ceramics, and who has accomplished such high results in ceramic science and art, as to have earned universal approbation.

Alfred is a small village, nestled between wooded hills on a tiny stream a short distance from railroads and main highways and cities. It is without any manufacturing,

but in the midst of centers of industrial, mining and trade activities. There is evidence that Alfred has been set apart as a charming cloister where man can dream and think in quiet seclusion and yet be in close contact with the world's business and manufacturing activities. Its location is ideal for such an investigator and thinker as is Dr. Binns. The scenic beauty of those Allegheny hills and the placidness in the human activities



of that village actuated as they are only by natural and intellectual pursuits rather than commercial, harmonizes well with poetic and artistic habits of mind of Dr. Binns.

In Alfred, Dr. Binns, for twenty-five years, has lived in this close relation to nature. He has had personal and intellectual contact with the philosophers, historians, scientists and artists of Alfred University. And he has been only a short distance from the

realities of ceramic production and sales. It is this fine harmony of situation and natural artistic talents that has given Dr. Binns a distinct if not an unique character as instructor in ceramics. This ideal combination of location with natural talents is reflected in the direction he has given to the application to ceramics of scientific fact

and artistic concepts. It is reflected in the transmission of these truths to the inquiring youth and to the producer in terms of usable ceramic products.

To be honored in "his own country," to be deemed worthy of the highest regard by those with whom he has labored for twenty-five years, to hold the unanimous loyalty

and love of those who have gone from his classroom and laboratory into manufacturing plants, to have the universal approbation of the captains of the ceramic industries because they have tested and found useful the ceramic science and art as taught and practiced by him; these are cherished rewards for having kept for twenty-five years in tune with nature and with a mind searching for scientific truths in a cloister near by but out of sound of the industrial world. Dr. Binns has frequently had these rewards in spoken

words and in acts until assurance of their genuineness needed no formal certification, yet the honorary degree of Doctor of Science from Alfred University, the testimonial of appreciation on parchment from the American Ceramic Society and the endowment fund providing for an annual Charles Fergus Binns Medal are permanent records which will tell the generations to come of the big place which Dr. Binns has in university circles, in industrial ceramics and in the hearts of his pupils as a ceramist, teacher and man.

"E CONCREMATIONE CONFIRMATIO"

By Charles F. Binns[1]

"I went down to the potter's house and behold he wrought a work upon the wheels, and the vessel that he made of clay was marred in the hand of the potter and he made it again another vessel."[2]

The field of ceramics is very large and includes all the substances which are produced from silicate materials and made permanent by fire but in order that this address may not exceed the proper limit the discussion will be confined to the origin and develop-

[1] Doctorate Address at 1925 Commencement, Alfred University, N. Y.

[2] Jeremiah, Chap. 18, vs. 3 and 4.

ment of the clay ware commonly known as pottery with an ultimate arrival at the production of stoneware and porcelain, a consummation involving the attainment of the highest skill in ceramic art and engineering.

It is not a matter for surprise that the primitive potter used clays which were easily obtained. In fact, it is certain that the clay itself suggested its own use. Tracks made by the feet of beasts and men must have revealed the impressionable quality of moist clay and from the suggestion thus provided it is not a great distance to the shaping of a jar. The discovery that clay could be hardened by fire was another and equally important step. In the semi-tropical lands to which are traced the beginnings of civilization, sun dried clay may have achieved some practical importance but with the exception of brick no remnant of this can be found.

The product of the potter is to be considered, not in any relation to the antiquity of man or the age of the earth, but as a distinct tribal or national development. Pottery has always formed one of the chief evidences for the guidance of the archeologist.

The pottery of the Stone Age was made by hand but this does not mean that it is all alike. The work of the aboriginal American affords a series of excellent illustrations. The northern tribes could not carry large jars on their frequent migrations. It was easier to make new ones at each encampment. Therefore, a considerable number of undamaged pieces is found but they are evidently for temporary use. Farther south where the residence was for longer periods, more time was spent on the work. It was finished and often decorated. The valley of the Mississippi contains many excellent examples. Then among the Indians of New Mexico where houses took the place of tents the pottery assumes a distinct style and is painted with colors.

With the knowledge of metal working which characterizes the age of iron the potter's wheel was invented and a new type of clayware appears. The form is now true and often beautiful, the surface of the clay is polished and the decorations are founded upon the principle that a rotating jar can be overlaid by lines and bands by simply holding against it a brush or tube charged with color. Incised lines were produced in a similar way by holding a sharp tool against the surface of the moving jar. The spaces between these lines were afterwards filled in by patterns of different forms.

The discovery that pottery could be glazed and thus be made impervious to water marks an epoch in the development of the art. The peoples who never emerged from the Stone Age, such as the ancient Britons, did not glaze their pottery. The use of glaze is found only in those nations which outgrew this stage very long ago; notably the Egyptians, the Chinese and the Greeks. The forerunners of the last named people were glazing their wares in great perfection fifteen hundred years before Christ and though the art declined and was apparently lost, some fine examples remain. Doubtless the beginnings were similar to those of other lands and nations but during centuries of progress these had been left behind. Documentary evidence in the Chinese empire is said to date back to 2500 years B.C. and many centuries before that there was a Chinese people. We find then a living nation which has a continuous history of at least 4500 years and, as this nation has from the beginning been a producer of pottery, it affords an unexampled field for the study of the art. We may pass by the very early stages, such as those already illustrated, and deal especially with the characteristic feature of Chinese work which consists in the use of a high temperature in the firing of the ware.

I must say a word first about the significance of high temperature and second, about the difficulties which attend its use. The essential principle, or what may be called the philosophy of the fire lies in the parallel facts that practicable clay must be so composed either naturally or artificially, as to be at once compliant and resistant; compliant in that the effect of temperature must be strongly evident, resistant in that the pieces shall, notwithstanding the compliance, retain their individuality and form.

If the former were lacking the ware would acquire no quality, if the latter, the quality would be lost in an ultimate collapse.

Careful experiments have shown that the firing of pottery in ancient times was at about the melting point of silver (960°C). So uniformly is this found to be the case that it is even conjectured that a silver wire was used as a test. Now this temperature produces only a mild redness in the kiln and while it protects the clay from disintegration it leaves it soft enough to be cut with steel and until this condition could be changed there was no possibility of an improvement in quality. The composition of the clay and the intensity of the fire are closely related and, in the process of evolution which we are considering, it came to pass that certain clays were found to be almost unaffected by the degree of firing which was then usual. What was more natural then than to try the effect of an increase in temperature? The result must have been a revelation to the potter. It did not come all at once. Probably centuries passed as the gradual use of hotter fires rendered possible the employment of wider and wider varieties of clay. It also became evident that the clays thus made available were of purer quality and hence produced pottery of clearer color and more attractive appearance, until ultimately there emerged at about the beginning of the Christian era, a stoneware, hard, resonant and durable. This result was achieved by the Chinese and from that time the progess was steady and sure. The point is, and upon this I wish to lay stress, that the necessary high temperature had been subdued to the use of the ceramist and that upon this fact the whole success of ceramic practice depends.

Stoneware having been perfected as to its essential substance the next step was the production of a glaze by which the surface could be made more attractive and which would permit the introduction of brilliant color. I have mentioned the occasional glazed ware which were made at an earlier period, but the practice of glazing had not become general. The use of glaze as an indispensable addition to clay ware must be credited to the pottery of the Han dynasty.

It took a thousand years to advance from stoneware to porcelain and hundreds of patient minds and hands labored in the development. The plan was not premeditated. Porcelain was not an ideal conceived and consummated but was the result of a slow and gradual transition. Hundreds of clays and rocks were treated and tried. The purer clays demanded higher temperatures and these in turn made possible the use of purer and purer clays. Only one type of clay can be used to make porcelain, pure white and so resistant to fire that alone it does not possess the necessary compliance of which we have spoken.

In the 14th Century the Mohammedan potters had found means to clothe their dark clay with a white surface and this corresponds exactly to the period when the Chinese porcelain makers had reached the summit of their art. During the great Dynasty of the Ming Emperors which began in 1368 the finest examples of porcelain were produced and the supremacy then gained is still secure. It is not difficult to account for this success. The Chinese craftsmen possessed all the qualities necessary for the production of fine work, skill, patience and a well-balanced critical sense and they labored in an atmosphere of appreciation.

We can only mention the enameled ware of Spain, Italy, France and Holland, all of which were inspired by the same ideal of a brilliant white surface, and pass at once to the genesis of porcelain in Europe. Late in the 17th Century the potters of France had so refined their preparations and processes that they were able to produce an excellent imitation of the Chinese ware.

It is not quite certain where the priority of this development belongs. In the year 1690 there is found a published statement referring to the "secret of making porcelain objects" but this may refer only to the enameled pottery which was then in vogue.

Eight years later, however, an English physician wrote, "I saw the poterie of St. Cloud with which I was marvellously well pleased for I confess I could not distinguish between the pots made there and the finest china ware I ever saw." From the establishment of St. Cloud there arose the enterprise at Vincennes which was ultimately transferred to Sevres to become the Royal Manufactory of France with King Louis XV as the sole owner. In all of these instances the ware made was soft paste china. The true clay had not been found in France although search had been made for it. Seventy years after the publication of the report of the English doctor it is said that one Madame Darnet, the wife of a French physician, found some white clay in a ravine near her home at Limoges. She, careful soul, was accustomed to launder her own linen and thought that this substance might serve instead of soap. She took a supply home with her and showed it to her husband who happened to know of the demand for kaolin. He submitted a sample to the King's chemist, Macquer, who identified it as the much sought for substance. Sevres was now able to make true porcelain and in 1804 the old and costly soft paste was finally abandoned. These kaolin beds are now known to be the best in the world.

Shortly before this time the pure clay had been discovered in Saxony and a porcelain identical in composition with the Chinese was made. There is also a legend relating to this discovery. The alchemists of that time had two chief objectives, the elixir of life which was to enable men to live forever and the philosopher's stone which was to turn base metals to gold. One of these men, Johannes Böttger by name, was employed by the King of Saxony in the search for these secrets. He had occasion to use high temperatures and needed crucibles of clay. All that he could find was red clay of good quality but which was not sufficiently refractory. Incidentally he made from this some excellent brown pottery, examples of which may be seen in museums. Those were the days of powdered wigs and Böttger, donning his headgear one morning, was struck by its unusual weight. Making inquiry he found that his servant had used a new hair powder. He shook some of this from the wig and examined it. It would not take fire, it would not dissolve. Remember that the mind of the investigator was attuned to the properties of clay and that the idea of porcelain was in the air for the King had already made a small collection of Chinese ware. Böttger was naturally greatly interested. He tested the new powder and found that he had possession of the true porcelain clay. Steps were taken to secure the source of the material and the King, with a sublime and regal disregard of the liberty of the subject incarcerated Böttger in the castle of Meissen with a corps of assistants and charged them to produce results. Thus the well-known Dresden porcelain came to birth. Let us note here that discoveries do not come by accident. The mind and the fact come together at the proper moment. This had been abundantly illustrated in astronomy, in chemistry and in physics. Had our alchemist not been awake to the significance of the phenomena he was observing he might have passed them by and the discovery would not then have been made.

In England pottery had been produced from very early times but it was crude in quality. The art showed no great advance until the time of Josiah Wedgwood under whose influence many improvements were made both in composition and workmanship. In 1813 one Miles Mason took out a patent for his Ironstone china the composition of which was based upon a curious association of ideas. Mason had observed the smelting of iron ore and thought that perhaps the glass-like slag which was drawn from the blast furnace might have acquired some of the properties of the iron itself, notably, strength. He thought that if he could succeed in incorporating some of this material with the substance of his pottery, this in turn might partake of the strength of the iron and so prove unbreakable. The slag did, in fact, strengthen the pottery because it consisted

largely of lime. But the name Ironstone was given in the belief that this long distance association with iron had provided a ware stronger than the common stuff.

Chinese porcelain or, as it is sometimes called, hard porcelain, is the prototype and the standard of all whiteware which are either procelain or an imitation of it. The modern ware of the continent of Europe are technically the same as those of the Chinese but in England it is different. Not porcelain but china is the white translucent ware made there. The original Chinese porcelain in common with almost all ancient ware was fired in the kiln but once. The glaze was painted or poured on the piece while in the clay state and one fire vitrified the body, fused the glaze and united them into one completed work. All true porcelain is made thus to this day except that the modern methods of manufacture demand a gentle heating of the clayware before the glaze is applied, in order to avoid breakage. This is merely a concession to factory methods and has no effect whatever upon the finished piece. When the French potters evolved their translucent ware from the fine earthenware of their regular practice they perpetuated the earthenware methods which consisted in a double firing, once for the clay ware and a second time for the glaze. These two fires were rendered necessary by the fact that the glaze in use was exceedingly fusible and needed only a low temperature to produce a brilliant surface. If a one fire process had been practiced, either the temperature must have been high enough to harden the clay, in which case the glaze would have been spoiled or it must have been low enough to suit the glaze in which event the clay would not have been strong enough to endure. Possessing ready to hand a brilliant glaze, all that was necessary was to improve the clay mixture sufficiently so that it would become white and translucent at the temperature which then served. This was accomplished by the introduction of artificial compounds and the super-addition of the glaze completed the work and produced the ware which was called "pate tendre" or soft paste. The so-called soft porcelains of France and later, of England, therefore are porcelains only in appearance. The technique of their manufacture is quite different and therefore I, for one, prefer to withhold the name porcelain, reserving it exclusively for the once fired ware.

Passing by some early endeavors at ceramic production in this country, we find that pottery of all kinds, even brick, was at first imported. The so-called colonial ware were made in England and printed with American views. A good deal of Chinese porcelain also found its way to these shores but in the early part of the 19th Century there grew up in Trenton, N. J., a colony of potters, mostly Englishmen. They were attracted to the locality by the existence of an abundance of clay which, while not of the finest quality, was suitable for the crude household ware which were in demand. When improvements were desired English clays were sent for and to this day are very largely used. No attempt was made to produce china or porcelain, the manufacturers contented themselves with making earthenware, more or less white, for which there was a large and growing demand.

Not until about the year 1885 was the characteristic American ware known as Hotel china manufactured by the Greenwood Pottery Company. For a long time this held the field against all comers but at the present time a ware even better is being made in several factories. This ware was especially designed to withstand the hard usage of hotel and restaurant service. The body is vitrified and translucent but the color is not as good as that of porcelain or English china. Hard porcelain is not made here for table use. The same ware, of course, in different form serves for spark plugs and electrical insulators and these we make in great perfection but we have never learned the art of producing porcelain tableware. The reason is that American potters learned their art from the English who make, as we have seen, not porcelain, but china and the technique of manufacture of these two wares is widely different.

In the progress of our study we have noted that the phenomena which appeared from time to time were to a large extent unexpected. The men who practiced the art of ceramic production were guided by happenings which they had not intentionally planned and for which they were often unprepared. This condition, while it contributed to the variety of ceramic product, was not adaptable to the demands of an advancing civilization. It was inevitable that some attempt should be made to take advantage of accumulating knowledge and to compare the results of experiments. Means were sought for measuring and regulating the advance of temperature during the firing process. The chemist was called upon for information as to the composition of materials and extensive research was carried on in the compounding of glazes and colors. It is characteristic of the art of the potter that the craft preceded the science. In fact, one of the stumbling blocks lying in the path of progress is the difficulty of persuading those who have been trained in practice that their work cannot be perfected without a knowledge of theory. This proving of theory by practice and illuminating practice by theory is education.

In Alfred we are especially interested in the necessary training to be given to those who expect to engage in the production of ceramic ware and perhaps enough has been said to convince you of the complicated nature of the processes employed as well as the intricate constitution of the materials. No one who has not acquired a fairly accurate knowledge of the science of chemistry can expect to comprehend the fundamental relations of substances to each other under conditions of high temperature, especially when these substances are themselves of complex composition. A ceramic engineer is not necessarily an analytical chemist but he must be familiar with the nature of chemical reactions so that he can accurately articulate cause and effect and confidently predict results. But chemistry is only a beginning. Physical reactions are of equal and often greater importance. For instance, the drying of clayware rapidly and safely may seem to be a simple thing but an error in this may cause disaster. At the present time there are probably more inventions relative to drying than to any other single process. Fortunately this problem is not confined to clay and much has been learned from the industries devoted to lumber, textiles and even candy making. The processes of firing are largely physical. Combustion is a chemical reaction but draft, pressure and vacuum are in the field of physics. Nor must we ignore mechanics, the production and transmission of power, economical grinding and sifting, wheels for shaping and turning, and the application of heavy pressure to steel dies; all of these are part of the day's work in some phase of the industry.

The quality of clayware is shown either by durability or by beauty. In almost every product both of these are evident though one or the other may predominate in each case. Sometimes a piece is sold because its appearance is pleasing, sometimes because it is strong and useful. Even a brick should play its part in a beautiful structure and an ornamental vase should be capable of use.

"E Concrematione Confirmatio," "out of the fire comes firmness," "through stress we pass to strength."

NOTES FROM THE CERAMIC SCHOOLS

Alfred University[1]

There are fifteen men graduating in the class of '25 this June. The following list shows where some of them will be placed next year:

Orray T. Fraser, National Fireproofing Co., Perth Amboy, New Jersey

---

[1] Joyce Baldwin, *Secretary.*

George H. Garnhart, National Fireproofing Co., Cleveland, Ohio
Leslie F. McConnell, Carborundum Company, Niagara Falls, New York
Henry E. Marley, Kier Fire Brick Company, Pittsburgh, Pa.
David W. Miller, Mellon Institute, Pittsburgh, Pennsylvania
Marvin H. Pond, Olean Tile Company, Olean, New York
Harold M. Rice, National Fireproofing Company, Perth Amboy, New Jersey
Frederick M. Strate, Alfred University, Collegiate Work
Stephen McK. Swain, Kier Fire Brick Company, Pittsburgh, Pa.
Duane W. Dailey, Bradford Brick & Tile Company, Bradford, Pa.

There are no changes in the Departments other than was reported before this year.

Georgia School of Technology[1]

About the only item of news that would be of interest to the readers of the Bulletin that we have to report is the research we are taking up in coöperation with the Central of Georgia Railway.

One of the problems will be the dewatering of washed kaolins. In Georgia there is a belt of sedimentary kaolins extending across the state for a distance of approximately 225 miles. This belt varies in width from 20 to 40 miles.

These clays, contrary to general belief, vary considerably in composition and physical properties and are classified in hardness from the flint kaolin to the soft kaolin. The soft kaolin alone filter-presses easily. However the preponderance of our deposits consists of what we classify as hard kaolin. The latter clays are not only more extensive but are more uniform in composition and color than the soft type. However, due probably to either the high colloidal content or the presence of free silicic acid, these clays do not filter-press easily.

Therefore our problem will consist in finding suitable electrolytes to coagulate this material and thus permit it to be filter-pressed, and also to investigate the feasibility of the use of a continuous steam drum drier for dewatering the clay slip. This problem will also include the tabulation of the costs of the filter press method versus the steam drum method. Laboratory work will be conducted in our department and the practical work in one of the clay washing plants that has volunteered to coöperate with us. Since our sedimentary kaolins contain from 80 to 95% clay matter, we will also determine the advisability of the manufacturer of whiteware refining these clays at the factory, which would save the cost of dewatering the clays which is now done by our clay washing plants.

The second problem will be an investigation to determine the best methods of obtaining a uniform blend of materials suitable for definite ceramic purposes. At the present time our clay washing plants are unable to deliver to the ceramic industry, materials that are uniform throughout any great length of time.

A third problem will be an investigation to determine the adaptability of certain of our clays for the manufacture of saggers. Saggers not only must be able to resist the temperature but must not deteriorate on continued heating. Most saggers flake off, after repeated use, and, in adhering to the glazed ware, ruin hundreds of thousands of dollars worth of ceramic products annually. The work done so far on some of our clays indicates that they will to a large extent eliminate these difficulties.

W. H. Vaughan, who receives his master's degree in Ceramics this year from the University of Illinois, will join us June 15, to engage in this work.

[1] A. V. Henry, Professor, Ceramic Engineering.

North Carolina State College[1]

1. No graduates.

2. George Reed Shelton appointed Assistant Professor, effective Sept. 15, 1925. Will handle classes in Glass, Cements, Whiteware and Enamels. Dr. Shelton comes from the University of Saskatchewan.

3. Ceramic building and kiln laboratory expected to be ready for occupancy at beginning of next college year.

4. Department will have 20 to 30 students next year.

5. Enrollment in Ceramic Correspondence Courses has passed 100 and is steadily growing.

6. Department has made a complete survey of the ceramic industries of the state in the past year and will complete a survey of the ceramic raw materials by July 1, 1925.

Ohio State University[2]

Prof. Arthur S. Watts, head of Ceramic Engineering at Ohio State University, announces the following additions to the teaching staff of that department.

John L. Carruthers, Assistant Professor of Ceramic Engineering. Samuel R. Scholes, Special Lecturer on Silicate Technology. Frank C. Westendick, Instructor in Ceramics.

Mr. Carruthers is a native of Colorado but a graduate of Ceramic Engineering at Ohio State. He has had practical experience in Terra Cotta and in heavy clay products manufacture and for the past two and a half years he has been Ceramic Engineer of the Harrop Tunnel Kiln organization. He will bring to this department all the most modern engineering knowledge in manufacture, drying and firing of ceramic wares.

Dr. Scholes is a leading scientist in the field of glass technology and is chief chemist of the Federal Glass Company of Columbus. He received his doctor's degree from Yale and was for several years Assistant Director of Mellon Institute of Industrial Research at Pittsburgh. Dr. Scholes has also had a wide experience in commercial glass manufacture and will by a series of lectures give to the students of ceramics a knowledge of the technology of silicates and glass manufacture not heretofore made available at Ohio State University.

Mr. Westendick has been student assistant during the past year and is advanced to the position of instructor. He has specialized in the study of the physical properties of clays and will have this subject in his charge.

James T. Robson who has been instructor in Ceramics for the past 6 years is leaving the department and will be attached to the Harrop Tunnel Kiln organization.

University of Washington[3]

M. E. Reynolds obtains his bachelor's degree in ceramics this month. His thesis subject is, "A study of the casting properties of some refractory clays of Washington." Mr. Reynolds is the eighth graduate from the ceramic department of the College of Mines to be actively engaged in ceramic work.

Other ceramic research work was completed this quarter by graduate students. H. E. Brandebury, holder of a coöperative research fellowship in the College and the U. S. Bureau of Mines, completed his thesis on "A preliminary study of some high-

---

[1] A. F. Greaves-Walker, Professor, Ceramic Engineering.

[2] A. S. Watts, Professor, Ceramic Engineering.

[3] Hewitt Wilson, Professor, Ceramic Engineering.

temperature refractory oxides." C. E. Curtis, who obtains his master's degree in chemistry, completed his thesis on, "The development of metal enamels using the feldspar, flint and quartz of Washington." Roland J. Clark, a ceramic graduate from the New York State School of Clayworking and Ceramics at Alfred University, has been appointed research fellow for the year 1925–26 and will report for work July 1st. J. R. Gednetz and Prof. Wilson will continue the research work on kaolin washing, whiteware pottery studies and refractories throughout the summer. A. S. Fahrenwald, metallurgist for the Bureau of Mines station at Moscow, Idaho, will act as consultant for the Seattle station in problems relating to kaolin and coal washing. Dean Milnor Roberts of the College of Mines will cover the states on the Pacific slope on a survey of possible sources of light weight building materials. During the spring quarter the upper-class ceramic students have made detailed inspection trips with reports on the plants of the Builders Brick Co., at Seattle; The Denny Renton Clay and Coal Co., at Renton and Taylor and the Northern Clay Co., at Auburn, Wash.

VOCATIONAL CLASSES IN CERAMICS TO BE ESTABLISHED

U. S. Potters Association and Ohio Ceramic Industries Unite in Work[1]

There was a very good attendance at the meeting held jointly with the Managers, Superintendents & Foremen's Forum at the East Liverpool Country Club the evening of May 22, 1925. The purpose of the meeting was to present the subject of Vocational Training in Ceramics to the School Board of East Liverpool, in the hope that definite action would be taken and a course instituted when school reopens in September.

The School Board and representatives of the Trades and Labor Council and National Brotherhood of Operative Potters were guests at the meeting. Arthur S. Watts, who is Director of the Ceramic Engineering Department at Ohio State University, and Ross C. Purdy, Secretary of the AMERICAN CERAMIC SOCIETY, were also present.

After a very excellent dinner, President Anderson introduced Joseph M. Well as toastmaster. Thomas A. Shegog, ceramic engineer of the Sebring Potteries, presented a paper on "Technical Education Methods," with special reference to those in use in Europe. Mr. Shegog outlined the various kinds of schools, colleges, etc., used in teaching ceramics, with special reference to those in Germany and England.

A. V. Bleininger presented a paper on "Technical Training in the United States," with special reference to ceramics. He briefly sketched the history of ceramic knowledge and ceramic education down to the present time, and touched upon the work of the night school he has been conducting in Newell, W. Va.

E. L. Heusch, Supervisor Trades and Industries, Department of Education, Columbus, Ohio, made an address on "Vocational Training in Ohio." He outlined the various methods used to give this training in other industries in the state of Ohio, and explained that no work of this sort had yet been done in ceramics. He also explained just what steps were necessary in order to secure state and federal funds to help the School Board of East Liverpool support such a school in ceramics.

Jason H. Brooks, President of the East Liverpool Board of Education, made a short address, stating that the Board of Education was in sympathy with the movement, and would seriously consider such a course immediately.

There was much interest shown in this movement, and it is the belief of the officers that this movement will be successful, as far as East Liverpool is concerned. East Liverpool was selected by the Executive Committee as the logical place to start the

[1] W. Keith McAfee, *Secretary-Treasurer*.

movement, because ceramics is practically the sole industry of this district, and it was thought that, therefore, there would be a more general interest in ceramic education than at any other point in the state. It is their purpose to extend this training as may seem advisable.

Those present were:

The Carrollton Pottery Co., The Owen China Co., W. I. Pope, The East Liverpool Potteries Co., The Colonial Co., Arthur S. Watts, Edwin Chetwin, J. M. Wells, The C. C. Thompson Pottery Co., DeWitt D. Irwin, Albert Bright, Thos. H. Cartwright, Harry Larkins, Thos. B. Anderson, Wm. J. Hall, Jr., W. Keith McAfee, John J. Orr, Frank Witherow, Thos. A. Bayley, J. H. Hepplewhite, R. V. Miller, Harry Jenkins, Wm. Watkins, H. J. McMasters, Ed. Carson, Albert Reidy, Bert Thorley, Hugh Meek, J. Frank Flower, Harry Deidrick, A. H. Aufderheide, Chas. Ashbaugh, H. R. Burson, C. A. Geisz, John Duffy, W. E. Geisz, J. T. Watkins, R. L. Baxter, C. F. Cannell, James Hall, Harry Bossen, Henry L. Koenig, A. V. Bleininger, C. G. Herbert, J. M. Davidson, T. A. Shegog, Smith Anderson, James Eardley, Enoch Faulkner, James Miles, W. L. Orms, Edward E. O'Neal, C. O. Bortner, Marion Shiveley, C. L. Pitcock, George W. Gosser, Theo. L. Koenig, John Pugh, O. N. Neal, J. D. Whitmer, E. Boardman, Samuel L. Earley, D. M. Cronin, Wm. Kress Cronin, C. A. Goodballet, Chas. F. Goodwin, J. M. Manor, Fred Schmid, J. B. Elliott, School Board Supt. and Clerk, J. C. Higgins, Will T. Blake, James Sexton, The Crescent China Co., C. T. Walker, J. W. Peckham, Ross Purdy, E. L. Heusch, Wm. Frost, I. A. Kruson, C. J. Kirk, W. E. Rice, P. D. Helser.

AN IMPORTANT COMPETITION

The Art-in-Trades Club[1] of New York announces a competition which, it is believed, will stimulate creative effort on the part of American designers, architects and manufacturers.

The program of this competition includes two projects—one the decoration and furnishing of two rooms at a cost estimated to be within the resources of a family with a yearly budget of $6000; and the decoration and furnishing of three rooms at a cost deemed appropriate for a family having an income of $30,000 or more.

Direct copies of old styles or obvious imitations of old designs will be barred from consideration. On the other hand, it is emphasized that the purpose of the competition is not to encourage the submission of eccentric or sensational in treatment, but rather to encourage the creation of designs that, while recognizing our present traditions, will carry forward the expression of these traditions into new and pleasing forms, suited for American homes.

The prizes will be $1250 for the design considered most successful by the jury for each of the two rooms involved in Suite A; and $1500 for the most successful design for each of the three rooms involved in Suite B. The two prizes offered for Suite A may be awarded to a single competitor or to two different competitors; those for Suite B to single competitor, or for two rooms to one competitor and the third room to another, or for the three rooms to three different competitors. A jury of five members appointed by the Art-in-Trades Club will pass upon the drawings and announce the awards on Oct. 15, 1925.

In announcing this competition the Club expressed the belief that "the initiation of such a movement in the near future was essential to the healthy well-being and progress of American industrial art." Continuing as follows: "The psychological moment for the inauguration of such a movement seems to be upon us. With the coming of

[1] *The American Magazine of Art*, June 25.

the great Exposition of Modern and Decorative and Industrial Art in Paris this summer, at which the United States will not be represented because we have not yet developed material suitable for display in the new spirit, the time is ripe for an awakening of our own efforts." It is for this reason that the competition is instituted.

Copies of the program of this competition may be obtained by addressing the Secretary of the Exhibition Com. of the Art-in-Trades Club, 34 East 38th St., New York City.

The Art-in-Trades Club previous to this time has held three annual exhibitions of interior decorative art in New York at the Waldorf-Astoria, at which they have brought together, in a series of twenty or more furnished rooms, examples of original wall coverings from France and England, antique furniture, and fine specimens of modern craftsmanship, both from original designs and in reproductions, together with rooms designed by present day decorators.

[1] "From an aesthetic point of view, no other exhibition can excel that of Louisiana. And the chief charm of the whole exhibit, from this point of view, is the exquisite Newcomb Pottery—vases and bowls, all with a background of blue, and patterns of Southern flowers and vines in relief and color. The placard of the exhibit explains that this ware was developed in the Newcomb School of Art, that it rapidly became famous and has taken several prizes. That it should take prizes and be famous is easy to believe; one would like to buy enough to put at least one piece in every room in the house. But like all gems, Newcomb Pottery comes high."

THE CERAMIC SOCIETY OF ENGLAND

A recent membership list of the Ceramic Society of England at the end of last Session totalled 676 members, made up as follows:

Honorary members	6
Collective members	98
Individual members	557
Student members	15

The present Session opened with a meeting of the Refractory Materials Section at Wembley, when the following papers were read and discussed:

"A Comparison of Gas and Coke Fired Drying Stoves together with a Description of the Construction and Operation of the Hüttenes Coke Fired Air Blown Furnace," by T. W. Barley.

"Some Properties of Clay Sillimanite Mixtures," by H. S. Houldsworth.

"The Influence of Exposure on the Chemical and Physical Properties of Certain Fireclays," by W. Hugill and W. J. Rees.

"On the Action of Heat on Kaolinite and Kaolinitic Clays," by W. Vernadsky.

"Alumina-Silica Minerals in Firebricks," by W. J. Rees.

"The Action of Heat on Kaolinite and Other Clays," Part II, by J. W. Mellor and A. Scott.

"X-Ray Investigation of Clays and Other Ceramic Substances. Researches into the Application and the Practical Value of the Method," by Assar Hadding.

"Note on the Storage of Silica, Refractories," by W. J. Rees.

"The True Specific Gravity and After Expansion of Lime-bonded Silica Bricks," by W. J. Rees.

---

[1] The Manufacturers Record, May 21, 1925.

"A Rapid Method for the Determination of True (or Powder) Specific Gravity," by W. Hugill and W. J. Rees.

This meeting was followed by the usual monthly meetings at Stoke-on-Trent when the following papers were given:

October.

"Some More Experience upon the Dorr Mill and Some Notes about Swedish Feldspar Industry," by A. S. W. Odelberg.

November.

"Pinholes and Some Other Things," by Harold J. Plant.

December.

"Notes on Crushing and Grinding Mills," by F. Lane.

January.

"Question Box," by various authors.

February.

"Tile Dipping Machines," by C. Reynolds.
"Visit to the Osmosis Plant at Karlsbad," by S. R. Hind.

March.

"Dust Counting," by E. L. Middleton.

April.

"A Note on Whieldon Pottery," by W. Emery.
"A Note on Frit Kilns," by S. R. Hind.

BUREAU OF MINES TRANSFER ORDERED BY THE PRESIDENT

Transfer of the Bureau of Mines and the Mineral Statistics Division of the Geological Survey from the Department of the Interior to the Department of Commerce was made in an Executive order issued by President Coolidge.

The transfer is made in the interest of more efficiency and economy, and was recommended by Secretary Work of the Interior Department more than a year ago.

The Bureau of Mines is the second to be transferred by Executive order from the Interior Department to the Department of Commerce. The first was the Patent Office. That transfer also was recommended by Secretary Work, who has given much attention to the reorganization of the Government departments to prevent duplication of work and more efficient and economical administration.

The appropriation for the Bureau of Mines, amounting to about $2,000,000 is also transferred to the Department of Commerce, together with the equipment of the bureau.

Two offices of the Bureau of Mines will remain under the Interior Department, those engaged in coal, oil and other mineral land leasing work.

The research laboratories in the Department of Commerce carry on investigation into the quality of materials for manufacture of porcelain, whereas the Bureau of Mines laboratories carried on research into raw materials for porcelain manufacture. The Department of Commerce laboratories carry on investigation into the qualities of fuel, whereas the Bureau of Mines laboratories tested fuel as to its qualities. The Department of Commerce contains a division for service in domestic distribution and foreign trade in mineral products, the Bureau of Mines carried on work of economic character of much the same implication. The Department of Commerce provides statistics

of mineral production every 10 years, in some cases every two years, whereas the Department of the Interior provides statistics of mineral production every year and in many cases every month.

While by constant adjustment conferences and the appointment of coöperative committees a considerable amount of the actual duplication has been eliminated during the past four years, nevertheless such duplications cannot be eliminated and the confusion of citizens in dealing with different Government departments for different purposes cannot be planned out unless single-headed authority is given for functions having the same general major purpose.

Over a year ago it was recommended to the joint committee on reorganization of the executive departments that the Bureau of Mines should be placed in the Department of Commerce. The transfer made today presages action by the Congress and opens the way for the transfer to the Department of the Interior of bureaus from other executive branches of the Government administering public lands and public works, as recommended by this committee. H. Foster Bain has recently resigned as director of the Bureau of Mines. His successor will be appointed by the President under the law. Undoubtedly, however, the appointment will be made on the advice of Secretary Hoover, under whom the Bureau will now come.

TEN YEARS OF INDUSTRIAL AND SCIENTIFIC EFFORT (1914–24)

The last ten years have seen prodigious efforts exerted in the domains of scientific and industrial chemistry.

The volume "1914–1924" which the "Societe de Chimie Industrielle" is preparing to publish, brings these into relief for all the specialties of applied chemistry. It will establish equally the economic balance of each of the industries of France connected with chemistry and will present the development in the colonies of the production of raw materials needed in these industries.

This important work will present voluminous reports prepared by persons competent in the world of Science and Industry. There will be nearly 3000 pages of quarto. Subscription is now open at 120 francs until June 1925. After that the price will be 200 francs.

Subscriptions will be received by La Societe de Chimie Industrielle, 49 Rue des Mathurins, Paris.

THE CARBORUNDUM RADIO DETECTOR UNIT

Another chapter has been written in the romance of carborundum. The Carborundum Detector Unit is of the cartridge type and is made with carborundum specially manufactured and tested for radio use exclusively. It is fixed and permanent; no adjustments are necessary. It remains sensitive indefinitely and will not burn out. It makes possible a sharper tuning, the reception of clear true tones, greater selectivity and greater volumn and distance on any properly constructed reflex or crystal set. It can be used in place of a detector tube with splendid results.

SILLIMANITE MINE DISCOVERED IN INDIA

A mine containing unlimited quantities of sillimanite, the best refractory material known, has been discovered in India and the right to work it has been acquired by Henry A. Golwynne, New York importer of chemicals, it is announced by Mr. Golwynne's

office, 26 Cortlandt Street. Mr. Golwynne intends to import the mineral in large quantities to the United States, and one test shipment is already on the way.

The mine is about 100 miles from Calcutta and within two or three miles of a railway. The extraction costs are small, for the ore lies on the surface of the ground in tremendous boulders, some of them as much as 100 yards wide and 100 yards long.

This is the first deposit of sillimanite in large quantities to be discovered. The mineral has long been greatly desired by all users of refractory materials. Industrial engineers have long recognized the extremely great value of sillimanite as a refractory material. According to the *Chemical Trade Journal* of London, "Sillimanite has many valuable properties which render it suitable for use as a refractory material among which are strength and toughness, a high melting point (1810° C) and stability at that temperature, low coefficient of expansion, low electrical conductivity, freedom from volume changes, neutral reaction and resistivity to corrosive slags and to oxidizing and reducing condition."

According to the *Chemical Trade Journal and Chemical Engineering*, London, bricks made of natural sillimanite have been recently tested in England with great success. They have been used in Babcock-Wilcox boilers, and it was found that after having been brought to a temperature which would completely melt other types of refractories, the sillimanite bricks remain in virtually perfect condition.

A FRIENDLY CRITICISM[1]

Ceramic Education

A period of anniversaries goes by and a month does not pass but that a centenary is announced; the "weeks" follow one another, the speeches resound and are repeated by all the echoes, singing the praises of the modest pioneers who were always at the origin of great industries.

After the centenary of Portland cement in the course of which we were apprised that the small mason Aspdin had had the idea in 1824 to patent under the name now become universal the product that Vicat had invented in 1818, now the University of Columbus (Ohio) has consecrated the "week" of 15th to 21st of February to celebrate the thirtieth anniversary of the organization of schools of ceramics or of the courses of this industry taught in different colleges of the United States.

In the course of this manifestation they did not fail to call attention to the efforts of Herman A. Seger in Germany and of Karl Langenbeck in America to put the industry of ceramics on the basis of a true science. But the part taken by Edward Orton, Jr. was also made evident in the development and in the systematic application of scientific methods recommended by his seniors, and which facilitated the discovery of new machines, new processes of treatment and mixtures of materials with a view to improve the production, to render it more economical and more fruitful.

If it is undeniable that the efforts which Orton made thirty years ago are of paramount interest, it is very probable if the old archives of Sèvres, Vierzon, Limoges or elsewhere, were dug into, that it would also be possible to organize here (in France) a "week" in the course of which there would be discovered a savant or even a simple brickmaker whose works would have been the basis of the ceramic industry in France and perhaps abroad as well.

[1] This notice appeared recently in *Revue Materiaux Construction Travaux Publiques*, published in Paris, France. Translated by Louis Navias.

CALENDAR OF CONVENTIONS

Organization	Date	Place
Am. Assn. Advancement of Science	Dec. 28–Jan. 2	Kansas City, Mo.
Am. Assn. of Flint and Lime Glass Mfrs.	July, 1925	Atlantic City, N. J.
AMERICAN CERAMIC SOCIETY		
(Annual Meeting)	Feb. 8–13, 1926	Atlanta, Ga.
(Summer Meeting)	July 4–11, 1925	Toronto, Canada
(Fall Meeting)	Oct. 1, 1925	New York City
Am. Electrochemical Society	Sept. 24–26, 1925	Chattanooga, Tenn.
Am. Engineering Council	Jan., 1926	
Am. Foundrymen's Association	Oct. 5–9, 1925	Syracuse, N. Y.
Am. Gas Association	Oct. 12–16, 1925	Atlantic City, N. J.
Am. Inst. of Min. and Met. Engineers	Aug. 31–Sept. 5, 1925	Salt Lake City, Utah
Am. Soc. of Mechanical Engineers	Nov. 30–Dec. 3	New York City
Am. Zinc Institute	April 27–28, 1926	St. Louis, Mo.
Assn. Iron and Steel Elec. Engineers	Sept., 1925	Philadelphia, Pa.
Coal Mining Institute of America	Dec. 9–11, 1925	Pittsburgh, Pa.
Common Brick Manufacturers Assn.	Feb., 1925	
Institution of Chemical Engineers	July 13–16, 1925	Leeds, England
Mining and Met. Society of America	Jan. 12, 1925	New York City
Natl. Association of Manufacturers	Oct. 26–28, 1925	St. Louis, Mo.
Natl. Exposition of Power and Mechanical Engineers	Nov. 30–Dec. 5	New York City
Natl. Exposition of Chem. Industries	Sept. 28–Oct. 3	New York City
Natl. Paving Brick Mfrs. Assn.	Jan., 1926	
Natl. Safety Council	Sept. 28–Oct. 2	Cleveland, O.
Optical Society of America	Oct., 1925	Ithaca, N. Y.
Sand-Lime Brick Association	Feb. 9–15, 1926	New Orleans, La.
Soc. of Chem. Industry	July 13–17, 1925	Leeds, England
Natl. Society for Vocational Education	Dec. 3–5, 1925	Cleveland, Ohio
Natl. Exposition of Coal Mining Machinery	Dec. 2–5, 1925	Cincinnati, O.

BULLETIN

of the

American Ceramic Society

A Monthly Publication Devoted to Proceedings
of the Society, Discussions of Plant Problems, Discussions
of Technical, Scientific and Art Questions and
Promotion of Coöperative Research

Vol. 4 August, 1925 No. 8

EDITORIALS

WHAT THE SOCIETY IS AND WILL BE

The purposes of the Society are limited to promoting activities in support of researches and education in the science and technology of ceramic production. The Society operates through committees, meetings and publications. The seven Industrial Divisions of the Society are self-organized and motivated, each according to rules of its own formulation not in conflict with the general constitution and by-law provisions. Representatives from the Divisions make up the general committees, as also the Board of Trustees, thus making a democratic, "home rule" federation of all ceramic industrial groups, coördinated through a central office and board of control for the purpose of promoting research and education in ceramics generally.

The Society as now operating does not conduct laboratory investigations. The committees do search the literature for the purpose of compiling data, bibliographies and references. The Divisions and Local Sections hold meetings for the purpose of reading and discussing papers and committee reports. The Society publishes a *Journal* monthly in which is recorded the papers, discussions and committee activities. It also issues bibliographies and other collected information.

The Society is representative of all ceramic interests, the producer and user of ceramic products, the press, the schools, the research bureaus and

institutions. The financial, moral and intellectual support necessary to maintain such a central organization comes from those persons and corporations who believe in technical advancement through research and education.

The SOCIETY, as now constituted, cannot finance research nor conduct schools. It can continue to plan and advise on ways and means of making investigations, to collect and broadcast information. Trade associations, institutes by trade groups, the trade press, the universities, the art schools and clubs, the Federal bureaus, and the state surveys are essential factors to technical advancement in ceramics. These the SOCIETY encourages and coöperates with always. The ceramic departments in the Federal bureaus and some of the ceramic schools resulted directly from promotional activities initiated by this SOCIETY.

The SOCIETY coöperates with all organizations which deal with things relating to ceramic manufacturing.

Realizing the effectiveness of each group dealing with its own peculiar manufacturing problems, the SOCIETY proposed that manufacturers of like materials, through their respective trade organizations have a joint Research Institute. A scheme was presented and is being considered whereby these several institutes may collaborate and, on problems of common interests, join in support. The SOCIETY has even gone further in proposing that when all the industrial groups will have organized Research Institutes that they take over the SOCIETY and make it a joint means of promoting their several research and educational activities. Such would be the natural and the most economical outcome, for surely this SOCIETY will continue to be truly representative of all ceramic interests and there is no need of another central pooling agency in ceramic research and education. Form of organization, control and activity are readily amended to conform to the most productive service. Neither personal nor organization prejudices need be a factor. The AMERICAN CERAMIC SOCIETY will continue because it is of, by and for all ceramic interests, personal, corporate and institutional.

A GRADUATE FROM THE "SCHOOL OF HARD KNOCKS"[1]

Carrying last month's editorial a little further, not so very many months ago a learned professor made the statement: "I tear out the advertisements from all my magazines as soon as they come." It so happened that he was asked during the course of the conversation "where could such a particular article be obtained?" and his reply was he did not know. The

[1] Sent in by a member of the Society, himself a graduate of the school of "hard knocks."

article in question is one that is nationally advertised and if he had been a reader of the advertisements, he would know where to obtain the article.

Surprising as this may seem coming from a college professor, one whom you would expect to be a careful reader of advertisements, these cases are in the minority. Nevertheless, the advertisements not only in the *Journal* but all publications, carry a certain amount of information which, if properly analyzed, will serve as an education on the thousand and one things on the market.

Take for instance the Ingersoll-Rand Co. Recently they advertised their "service" and along with that they told of the many, many jobs their air drills and hammers were put on before they were placed on the market. After reading their advertisement we concluded there was considerably more to air drills and hammers than the average person had any idea of.

The Hercules Powder Co. have also carried on educational advertising telling of the way in which the ancients used to break stone, etc. It was of course, all bringing the reader up to the present day item they were manufacturing.

Now that the Educational Committee is starting on an educational campaign, those who are in the school of hard knocks, and those who were taken from school because of family necessities like Josiah Wedgwood, are eagerly watching for a pictorial description of the various things taught them.

Take, for instance, a pump recently shipped to the mountains of Central America. It arrived from the United States and the college engineer on the job was called away to another section needing his immediate attention. His departure left a student from the school of hard knocks in charge. The pump was needed badly but, being dismantled, could not be used. The company had previously met with such incidents and were prepared in this case—the result was a pictorial and plain English description of how to put the pump together. This did wonders for the manufacturer of these pumps and he is "cashing in" on it by selling to farmers who do not know any more about pumps than we do about what will happen next week.

Advertising in itself is an art, capable of being used to tell in words and pictures what is being done. Take away advertising and this would be a sorry place to live these days. To read and study the advertisements for only a minute, is like taking a short course in college—all the "dry rot" is removed and only the important items mentioned, enough so that, if you are interested, you can get all the technical details if you desire them.

PAPERS AND DISCUSSIONS

STUDY OF KILN LOSSES—AN EXAMPLE OF VALUE ACCRUED FROM COÖPERATIVE RESEARCH[1]

By George A. Bole[2]

About four years ago, Mr. Bleininger then with the Bureau of Standards, approached the heavy clay interests of the country through their respective associations in regard to research into the firing of heavy clay wares.

Mr. Bleininger was, I believe, working through the American Ceramic Society and the National Research Council.

Four of the associations approached took kindly to the idea and formed a Central Executive Committee, which committee instructed Mr. Bleininger as chairman, to select a Technical Committee, which he did. The research was planned by and carried out under the general supervision of this committee.

Less than a year after the field work of this investigation was completed, a group of refractory manufacturers approached the ˇ ureau of Mines in regard to the possibility of carrying on investigations into the economy of firing refractory wares. Satisfactory arrangements were made through a committee of the Refractories Manufacturers Association.

The main differences in the two investigations were in method of financing and immediate purpose. The heavy clay investigation was financed by four heavy clay industries as a whole and the Federal Bureaus—Mines and Standards. The refractories investigation was financed by the plants visited in coöperation with the Bureau of Mines.

Field work of the heavy clay investigation was a general survey in a large field, the main purpose of which was to gather information. The refractories investigation has as its aim a demonstration of possible economies based on available information.

I wish to give you in a very sketchy way, some ideas in regard to coöperative research as carried out by the Government together with a few of the many interesting developments during the tests. My main purpose, however, will be to give you some idea in regard to what men in a position to know, think of these and similar researches.

My manuscript is therefore more than half either entire letters or excerpts from letters received in reply to inquiries sent out to the men who were in closest touch with the work.

It is as Mark Twain once remarked about a book that he was writing. He said that "it was both good and original. The part that is not original is good and the part that is not good is original."

In planning any researches in coöperation with industry, such as those in the firing of clay wares, there is always a well grounded difference of opinion as to how the work should be conducted.

We invariably have the group who believes that the only sure way to gather a lasting and increasing benefit is to solve the fundamentals once and for all. This group would carry out a research such as the heavy clay research under very accurately controllable conditions which would be capable of duplication from time to time, each phase of the work being attacked separately under conditions where one variable is studied at a time, all other factors being kept constant.

---

[1] Presented before the Summer Meeting of the American Ceramic Society, Toronto, Canada, July 9, 1925.

[2] Superintendent, U. S. Bureau of Mines, Ceramic Experiment Station, Columbus, Ohio.

At the other extreme is a group of so-called practical men who hold that we really have a great mass of information that has never been put to work to the limit of possibilities. Why not use what we have so as to make it understandable to, and usable by the man on the plant?

Both concepts are of course correct. We do need more fundamental data. There are some phases of the problem of fuel economy which cannot go forward until we have such data, but it is just as true that the data cannot be put to work except it be made available to the man on the job through considerable tutelage and much demonstration.

Both schools of thought were fortunately represented on the committee which outlined the heavy clay investigation.

The committee in charge was convinced as a whole that we did not know enough about kiln operation to be able to outline a fundamental research intelligently, but should first survey the field, leaving to a later date the more detailed study of each separate kiln operation. In addition to the gathering of this very general information they felt that much practical good could be accomplished by applying the fundamentals that we already had to the fuel economy problem.

The plans as finally agreed upon were to have the water-smoking and the oxidation of clay wares studied in a fundamental way at two of the Government bureaus and to study quantitatively the heat necessary to fire clay wares at one of our universities. It is worthy of note that none of these problems are yet completed although much good work has been done on each of them.

The field work consisted of sending a crew of six men—three ceramic engineers and three fuel engineers with laboratory car to plants firing various types of heavy clay wares in various types of kilns using various fuels. In all, twelve plants were visited.

The types of kilns tested were—round and rectangular down draft; continuous chamber, car tunnel and semi-scove. The ware fired was common brick, face brick, hollow building tile and paving brick. Natural gas, producer gas, fuel oil and coal were the fuels used.

Most of the kilns tested were equipped with natural draft induced by either single or multiple stacks. Natural, forced and induced draft, with a combination of both forced and induced in one instance, were investigated.

The field work had, in general, three aims: (*a*) the collecting of engineering data in regard to kiln design; (*b*) a study of the heat distribution (heat balance); (*c*) the application of available information to the practical art of kiln firing. The third item consisted of a study of possible economies in fuel, kiln turnover and in the production of a superior product.

The results of the laboratory studies in water-smoking and oxidation which would have been very helpful were of course not available at the time the field work was being carried out. Laboratory control methods were gradually developed but were of little service, so far as a more efficient field work was concerned, until near the end of the investigation.

It was not to be expected that a crew of young college graduates, even under competent supervision, with little back of them beside theory could get in a single demonstration the ultimate efficiency out of a given kiln. They did, however, demonstrate the *methods* whereby large savings could be and were later realized not only on the plants visited but at many plants where similar work has been done with this work as a basis and inspiration.

It was thought before the tests started that, as the investigation progressed, the crew would be able to make a much better job of it. With the exception of the heat balance work where technique is so large a factor, this did not appear to be the case, due to the fact that each succeeding test was so different from the preceeding type of kiln, raw material, ware fired and fuel used.

The task of correlating, tabulating and analyzing such a heterogeneous mass of data as that gathered during such an investigation was a monumental one and the conclusions drawn are at best only tentative.

Those unfamiliar with research who expected a recipe for firing all types of clay ware with all kinds of fuel in all types of kilns to result from the investigation were disappointed with the work. Those who realized from the beginning that such a research could be expected to form only the basis for further work, both fundamental and practical, were pleased.

All comments which have come to our ears have lined up somewhere between these two extremes.

A later investigation was undertaken in coöperation with a group of refractory manufacturers in which seven plants were visited. It was similar in general outline to the heavy clay investigation, but included only one type of ware—refractories—all fired in round down-draft kilns with the same type of fuel—coal. It proved to be a very much more satisfactory undertaking. Of course we must not overlook the fact that we had the experience and technique of the heavy clay work behind us as an invaluable aid both in planning and carrying out the investigation. This should be considered as one of the advantages accruing from the heavy clay research. However, discounting this fact, it was very apparent that reducing the variables enabled us to gather momentum as the work progressed and to compile our results in a more simple manner and in general to render a more direct aid to the coöperating parties.

During both investigations the same kiln at each plant was fired twice. The first time by the plant crew with the Bureau crew observing and collecting data. The second test was directed by the Bureau crew. It is most interesting to note that in every plant visited, with two exceptions, the kilns were fired off during the first test in a much shorter time than was plant practice and in many cases with a considerable saving in fuel—all of which goes to demonstrate that the average kiln foreman can do a better job than he ordinarily does when he feels that his reputation is at stake.

The most immediate benefit which accrued from these researches, but in the long run a minor one, was the actual saving in time and fuel which the crew demonstrated could be accomplished at the various plants visited. This saving varied from 0% to 50% in fuel and in time from an increase of 5% in one case to a saving of 45% in another. Kiln waste was reduced markedly at several plants. A demonstration of the methods through which savings could be expected was of far greater importance than the savings themselves, large as they were, as *it is through this means only* that the industry at large is benefited.

It would require a much longer time than is allotted me to either describe the work or to point out in an adequate way, what was accomplished at each point. You may be interested, however, to hear of a few isolated instances.

It was found in many cases that the efficiency of a kiln was greatly reduced by setting the ware improperly. In one instance a slightly more open setting with a false flue system over the floor cut the firing time in half—reduced the fuel consumption 40% and raised the marketable ware from a plant average of 80% to one of 95%. This and other similar examples stress the fact that the setting is in reality a vast system of flues which serves to distribute the heat properly and at the same time interferes as little as possible with the normal functioning of the kiln.

The fuel engineers were inclined to scoff at the ceramic engineers when they saw their first dead bottom fire box. Even when on somewhat more familiar ground, they were shocked when they saw their first 30-inch fuel bed on a horizontal grate. However, before the tests had proceeded far they were free to admit that many of the principles of efficient heat production in boiler furnaces are inoperative in the case of a ceramic

kiln. The fact became more and more evident as the tests progressed that efficient kiln firing is made up of two factors, namely, efficient *production* and efficient *utilization* of heat and, of the two named, the last is by far the more important.

The all important factor of the proper distribution of heat in a kiln was studied by thermocouples, blind cones and static pressures in the heating chamber and by porosity, shrinkage and specific gravity of the ware after it was removed from the kiln. Draw trials were resorted to in a few cases. As all these means of control are well understood by the ceramic engineer with the possible exception of static pressure, I do not need to comment further than to say that they all have an important place in the control of kiln losses.

A draft survey in several of the kilns demonstrated the fact that the heat distribution was especially good and kiln losses small when a positive pressure is maintained as far down in the kiln as possible and still maintain satisfactory operating conditions. A study of drafts at several points within a kiln often shows the cause of improper heat distribution where temperature measurements indicate only that such a condition exists. At one plant draft curves indicated the cause of a cold cone in the crown of the kiln to be due to a minus pressure well up in the center of the setting. The setting was later corrected and the cold cone disappeared.

At one plant where a difference of five to seven cones in kiln temperature was plant practice it was found possible to reduce this difference to less than three cones by firing one end of the kiln (New Castle type) very close (really a gas producer) and allowing the fires in the other end to burn down in order to admit sufficient air to burn the fuel gases within the setting. A change in the setting so as to produce a vertical rather than a horizontal flue system helped accomplish the desired results.

Kiln losses were reduced in two cases by employing induced draft. The normal losses were due to the settling of moisture in the bottom of the kiln with subsequent kiln marking and cracking of the ware. This condition was remedied by the more rapid elimination of the moisture as the water-smoking progressed.

Losses due to the flow of heat through kiln walls, heat stored in the kiln structure and in the ware, losses in flue gases, combustible in ash, etc., were studied and constituted the basis for figuring the heat balance. This work was the most important phase of the investigation so far as kiln design is concerned although the data in regard to kiln proportions can be of great value to the kiln designer as well as to the plant management.

There are other advantages which have accrued to the industry from these and similar tests in addition to the few examples already pointed out and many others of a similar nature which could be enumerated if time permitted. The advantages to which I refer are of a less exact type but are larger in their scope than are the more tangible ones. In writing to a number of the men most closely connected with these researches in the capacity of plant operators, technical advisers, and association secretaries, I find that the one point most commonly stressed is that these tests have demonstrated in a very specific way that savings can be made by the application of scientific principles to plant practice and that with such tests as an inspiration many plant superintendents have caught the investigative spirit and are producing results.

The most frequently expressed constructive criticism of the work, especially that on heavy clays, is that it stopped short of accomplishment in that it did not "get across" to the firemen. We candidly acknowledge that this is true and it should be the next step in a well-defined program.

The four association secretaries have expressed this same idea in very interesting communications which I shall read:

"I am afraid my views are rather well known on that subject (advantages accruing

from kiln investigation), and I am afraid that they are not very extensively agreed to by other members as to their results.

"I thought then, and still feel, that so far nothing has been accomplished to boast overly much about. A good start was made and no more. The Joint Research Committee instead of branching out into a highly theoretical field of doubtful value to the industry, even if its aims were accomplished, should have continued in existence under its own arrangement and should have devoted itself to devising methods of making practically available to the plants day by day, results that the research program indicated could be had if properly followed up. The Joint Research Committee and various bureaus of the Government, who may see fit to interest themselves in the matter, can do more service by considering the application of research data already gained than by the further accumulation of data.

"All the propositions I have heard so far discussed in regard to further research, I must confess, are so vague in their terms and purposes as to be obscured to technical men in the industry as well as the leading operators. My idea of further activity in connection with clay products research is to come down to earth out of the clouds and be practical rather than theoretical. I appreciate the fact that this is stated in the form of a negative view and therefore may not be constructively helpful. Nevertheless, there is a remedy when sufficient people are interested in the matter to apply the remedy."

Another communication states:

"There is no question but that our industry has benefited to a great extent by the publication of the research work undertaken by the Bureau of Mines in coöperation with the four heavy clay products industries.

"It is rather difficult, however, to get any definite statements as to results although one of our manufacturers did state that on a single plant he made a saving of $20,000 the first year. This probably has been duplicated to a greater or less extent in a number of other plants.

"One difficulty in all research work lies in the interpretation of these results to the small manufacturer who has not had a technical training. Undoubtedly, a great deal of the value is lost on this account but we contemplate an attempt to rectify this condition in the near future.

"I further believe that for the good of the clay products industry, this burning investigation should be continued and carried to a conclusion."

Another reply stated:

"The investigation of the Bureau of Mines was timed during a period of unprecedented research in burning facilities and methods. Without doubt, your work has vastly stimulated confidence in the fact that burning costs can be materially reduced. I believe that most of our members have carefully studied the burning report, and although we would not necessarily know about many cases, I am quite sure that the interests have been general and that the principal good has come from the stimulation of thought and study to apply your findings to different sets of conditions."

The other secretary reported:

"Roughly I would say that the results are just about in the same proportion as those resulting from the activities of this office. A minority of the membership will grasp and use any valuable information. Unfortunately the majority does not seem to know how to apply it. I think you can safely report, however, that out of our membership many of them have been able to apply the information resulting from your investigation and have made notable saving in expense on their burning process."

It will be interesting for you to hear the variety of opinions as to the value of these researches as expressed by plant operators. The five following letters are from plant

superintendents where plant practice was so good that little improvement was possible. You will note a just and excusable pride in the fact that their operation could be little improved by the Bureau crew.

(1) "We were much interested in the work of the committee at the time, but cannot honestly say that we actually received any benefits as the result of this work. We maintain a force of ceramic engineers of our own, and are constantly following the matter of burning of our kilns in our various plants, and therefore have collected considerable more data on this subject than would be possible on any one trip of the kind referred to."

(2) "You will remember that tests run by the crew at our plant showed no fuel saving to speak of and even a slight decrease in percentage of No. 1 ware, but it did at least prove that our methods then in use were fairly efficient and sound. It also gave us such information as the amounts of excess air carried at various stages of burning, the pounds of coal burned per square foot of grate area per fire at various stages of burn, and other similar data which has helped us considerably since that time, and which would have been very difficult for us to obtain otherwise."

(3) "We have improved our burning practice considerably since the crew was here. We have raised our finishing temperature about 2 or 3 cones and are burning our kilns much more uniformly from top to bottom than we were at that time. Our coal consumption has been increased slightly but not unduly, considering the better results we have obtained.

"How much of this improvement has been due to the work done by the crew here is hard to determine. We have applied some of the changes in practice recommended in your report and have gone just the opposite way on other recommendations. On the whole, the direct effect of the work done here has been rather small but the indirect effect has been very beneficial and has been well worth the money and time invested. By indirect effect I mean the effect of the crew's investigations upon our own men who handle the kilns. They have shown a spirit of coöperation in effecting changes in methods and a willingness to try out new ideas, which have been very gratifying.

"They now believe that there is something in the technical control of burning which will get results which cannot be obtained by rule of thumb methods and this belief of theirs has made our burning problems much simpler of solution than they were formerly.

"All of this has taken time to work out and I believe that we will derive further indirect benefits from your work as time goes on. I hope that this report will answer your purpose."

(4) "The only real result that I see from the work which your department did while at our plant was the fact that you furnished us with scientific and technical data as the result of the experiment. It must be acknowledged that you could not show a fuel saving nor a better product. We pat ourselves on the back in this respect and do not criticize the Bureau.

"The subsequent work done, however, at other plants, according to the reports which I have read, show that the work accomplished was wonderful saving of fuel, instructions to burners as to how best to control their kiln temperatures and fires, the best type of setting to use to obtain results and any number of other things that were brought out which have probably saved the industry a considerable amount of time and money.

"On a whole I would say that the work was more than successful and the cost involved was merely a 'drop in the bucket' with the savings which should result from such a series of tests."

(5) "The plant visited by the crew was greatly benefited by the data gathered. While very little time and fuel were saved, the methods developed by your crew un-

doubtedly improved the product and most important of all, increased the length of life of the kiln lining and bottoms.

"A number of the other plants visited by your crew have advised me that they were benefited not only as to improvement of product but were able to save both time and fuel."

Plants where large savings were made write through their superintendents as follows:

(*a*) "Since the publication (Burning Problems of Industrial Kilns) has reached our hands, we have made very great use of it. We have been able to shorten the time of burning somewhat and also decrease the amount of coal per thousand brick. The greatest advantage I find is attaining the scientific data with regard to our particular kilns. We were very much in need of these facts that the Bureau has given us.

"I sincerely hope that the Bureau of Mines may see fit to continue these inspections to other plants, for I know the good derived would certainly repay the effort."

(*b*) "We wish to say that the investigation called to the attention of our formen and also the workmen the importance of watching closely the details of burning.

"Also the importance of getting proper draft and having the kilns kept up in good order. It was important to the management in calling attention to the fact that a higher grade coal would produce better results.

"We are glad to have your coöperation in helping solve some of our burning problems, and we have no regret for the time, interest and money which was expended in conducting this test."

(*c*) "We would say that since investigation of our kilns by your crew, we have not experienced trouble with our standard brick in cracking from too rapid drying. Our actual coal consumption is considerably reduced as compared with amounts consumed in prior years, allowances being made for difference in cost of fuel and difference in rate of production.

"We feel that the money spent for this service has proven most profitable to us."

(*d*) "We were well pleased with the results obtained at our plant. We had felt that burning the ware was one of the processes of manufacture that we knew little about. We didn't know how our losses were distributed nor did we have any idea of the composition of the products of combustion. We did not have the instruments nor the equipment to measure these things.

"The work which you did taught us many things and also enabled us to study and think of these problems more intelligently ever since.

"Your suggestion that during a portion of the burn, one end of the kiln be fired as a producer and the other end supply the excess oxygen to burn this gas at the center of the setting, was a novel idea and a very good one and was practiced by us, with the result that we were able to increase the temperature considerably at the center of the setting.

"Altogether, we considered the work well worth while, and we are glad that we did it."

(*e*) "The work carried out by your department, I would say, was very important and of a practical nature. As a result of the data accumulated on our plant covering our burns, we have been able to effect some quite substantial savings in burning. In addition to this, I would say, that it attracted a great deal of attention from our men and had the effect of 'pepping them up' and caused them to do more thinking about their work. Such results are always helpful."

Interesting letters from two of the members of the Technical Committee in charge of the heavy clay investigation in which they express ideas both as to results accomplished and future work needed, follow:

"Answering your inquiry concerning the work which has been done on the subject of kiln firing, permit me to say that in my opinion it was well worth doing because of its educational value. It has aroused the attention of the manufacturers to the importance of doing systematic firing and saving both time and fuel by following the principles laid down in the report. It is very difficult to do strictly original work along these lines because much of it has been done before. But the present work was done in a more complete way than any other effort. It therefore represents a more unified investigation.

"I still believe that there is vital need of a fundamental study of heat transfer such as I tried to have incorporated in the research under discussion. This would deal with the velocity of the gases of combustion and the rate at which they transfer heat to the charge. It would also deal with the conditions of pressure within the kiln, that is, whether there is greater uniformity of temperature with minus than with plus pressure. I am sure that some day this will be done. The most outstanding feature of the work done is that of Dr. Washburn on the heat consumed in the firing of clay."

". . . .benefits accrued from this investigation were (1) more general knowledge of what happens at each stage of firing; (2) more general ability to use control devices; (3) economy in kiln management and (4) a fair idea of how the heat was used or wasted.

"Until more of the specific or fundamental data are had on heat reactions, absorption, and recovery in fuel, ware and kiln structure, exact determinations of the factors affecting economies cannot be determined.

"Until there are kilns available in which design and construction alterations can be made there is not going to be the largest return from the kiln study.

"A thorough demonstration of the use and value of control apparati, and a training of kiln firemen generally in their use would be a distinct step over the present general practice. The savings resulting from intelligent use of pyrometers have too often been demonstrated to warrant any one attempting kiln economies without their aid. Firemen generally should be trained in the use of draft gages; fuel and ash weighing and analyzing.

"In a word the greatest value ultimately from these kiln studies will be better kilns and better posted firemen."

INDUSTRIAL RESEARCH[1]

By E. Ward Tillotson[2]

The University of Toronto and the industries of Canada are to be congratulated upon the establishment of a course in ceramic technology in that great institution of learning. The ceramic industries are so basic in their relation to other industries and so essential in supplying needs of modern life that they are deserving of the best that science affords.

It is the purpose of the University to direct the advancement of science and to furnish men trained to serve the industries. It is the privilege of industry to take advantage of these products of the university for its greatest advancement.

The trained mind is an essential factor in modern industry. It may find its place in work of organization or management in which case special training in engineering and economics are required, or it may function along the line of research or scientific investi-

[1] Read at the Summer Meeting, American Ceramic Society, Toronto, Canada, July 9, 1925.

[2] Assistant Director, Mellon Institute of Industrial Research, Univ. of Pittsburgh, Pittsburgh, Pa.

gation of processes and products, which necessitates specialized training in one or more of the experimental sciences. Progressive industry is constantly pushing its outposts forward into new territory, broadening its field, improving its positions and, in addition, accumulating a reserve of knowledge in preparation for future development.

Science, the classified store of accurately observed facts, is dependent upon the powerfully effective instrument, research, to gain new knowledge. Industrial research translates this knowledge into practice, seeks new data which will be of practical value, and endeavors to utilize the facts and the methods of science for the greatest benefit of industry.

Technically trained men, engineers, chemists, ceramists, metallurgists, physicists and biologists, all products of the university, are important in industry because they have available or can procure and then classify and apply information of practical value. Science and research now have recognition and support in the United States because they are paying heavy dividends to American industry—one half-billion dollars annually according to conservative estimates. Their industrial future is rich in promise because they are constantly broadening their scope, their methods are growing steadily more effective and the means of reducing their accomplishments to practice are becoming more satisfactory. Industry must indeed look to institutions of higher education for men and means to insure its reserve of technical knowledge, to satisfy the requirements of the present technology and to prepare for the developments of the future. It is important, however, for the most effective industrial research that the university should not merely produce trained minds nor that industry should only utilize the services of technical men. The united efforts of both parties are necessary to accomplish the desired results, which require an appreciation on the part of the university of the needs of industry and an understanding on the part of industry of what the university is able to furnish. Thus industrial research serves as a connecting link, a strong and useful bond between science and education on the one hand and practice and industry on the other.

Certain lines of industrial research, to be sure, may well be carried out in the laboratories of individual companies and of associations, but that does not lessen the worth of what the institution of learning may contribute.

In the United States industrial, chemical and ceramic research is being conducted in laboratories of universities and in experiment stations connected therewith, in the laboratories of Government bureaus, in privately owned commercial laboratories, and in the research laboratories of corporations and of trade associations. The number of such investigations is constantly growing.

Mellon Institute of Industrial Research of the University of Pittsburgh represents the development in connection with a university of an extensive organization, the primary object of which is to conduct industrial, chemical and ceramic researches. At the present time 55 separate investigations are under way, requiring the services of about 100 highly trained investigators.

Of these 57 industrial fellowships, 11 are within the field of ceramics. One deals with general refractories, two with enamels, three with sewer pipe, two with glass-house refractories, one with special metallurgical refractories, one with flooring and wall tile and one with the manufacture of glass mirrors.

At present Mellon Institute is receiving from industrialists approximately $500,000 annually for the support of this work of which approximately $70,000 is devoted to ceramic investigations. The continued and healthy growth of Mellon Institute since the inception of its work in 1907 indicates, it is believed, a real and growing realization on the part of industry of the practical value of science and of research.

PITTSBURGH, PA.

CERAMIC ENGINEERING CORRESPONDENCE COURSES AT NORTH CAROLINA STATE COLLEGE[1]

By A. F. Greaves-Walker

Fifteen years ago one of the high grade institutes offering engineering courses by correspondence took up with me the question of the feasibility of giving ceramic engineering courses by correspondence. I could see no reason at that time why such courses could not be given, and after our experience of the past six months I am surprised that so fertile a field should have been left untouched. A study of the catalogs and bulletins issued by the correspondence schools and large universities offering courses by correspondence revealed the fact that practically every course of study that could be taken by resident students in the educational institutions of this country was offered except ceramic courses.

There can be no doubt that the technically trained ceramist has made a tremendous impression on both operators and workmen engaged in the various branches of the industry, during the past ten or fifteen years. This impression has been deep enough to create a desire, in hundreds of practical men who cannot attend college, for an opportunity to obtain some technical training. Heretofore the short courses offered the only opportunity for these men and they, naturally, could only reach a limited number.

While I had had no experience, either as an instructor or student in correspondence work, I could not see any reason why courses in ceramic engineering subjects could not be given as easily and successfully as physical chemistry, geology, heat engines, soils or mechanical drawing. I felt that if a practical man could read and understand an article in a trade magazine on such subjects as kilns or firing, he could understand, especially with some assistance, a text book or lecture.

All the correspondence courses offered by North Carolina State College carry college credit, this credit being based on from twelve to sixteen assignments or lessons equaling a three-credit course for one term in residence. This matter of college credit naturally carries with it the question of correspondence students meeting the college entrance requirements. It was my opinion, however, that few men in the ceramic industries, under the age of twenty-one years, would apply for these courses and this would allow us to admit them on the same basis as special students. As is the rule in other colleges, the question of admission of these students is based on consideration of the individual case. Each case is judged from a transcript of the student's school record submitted with his application for admission. So far about one-half of the sixty-two students entered have had only a common school education.

As we have been especially anxious to encourage men holding foremen's and clerks' positions we have tried to impress upon those interested that it is not necessary to take a final examination if college credit is not desired. In such cases when a man finishes his last assignment he has finished the course but is marked "incomplete" as is a resident student who fails to take his final examination. When a final examination is desired a high school principal or someone connected with an educational institution near the student's home is appointed an overseer. I might add here, that so far we have not refused to admit a single student, no matter how poor his preparation, and we have had no students who have requested a final examination for college credit.

We limit students to not more than two courses and advise taking only one at a time. Experience has shown that very few students can successfully handle more than two correspondence courses at a time.

In working up the first courses we decided to use available text books and as nearly

---

[1] Presented at the Summer Meeting, American Ceramic Society, Toronto, Canada, July 9, 1925.

as possible made each assignment cover one chapter. This could be done because the student is not limited as to time. There being very few text books, however, the courses worked up later were in the form of lectures.

When a text is used, a lesson aid of explanation of the text accompanies each assignment.

As nearly as possible the work parallels that given the resident students taking the same course. Under the circumstances it is necessary to simplify it as much as possible and to go into more detailed explanation. It is borne in mind, however, that practically all of the students have a plant background and that the plant is their laboratory.

Each assignment contains from five to twelve questions, usually ten, and the answers to these are returned to the instructor. It is assumed that the student will study the lesson and answer the questions without reference to the text or lecture, but it is readily noted that most of them practically copy the answers where possible. Personally I can see no great objection to this as I feel we have accomplished our purpose if we only succeed in getting the student to read through the text book or set of lectures. We are not, as in the case of resident students, interested in their keeping up to a certain standard in order to obtain a degree, because we do not require them to take a final.

It is rather remarkable that out of several hundred assignments that have been returned to me only three have failed to receive the passing grade of 60. Two of these were the work of a brick plant superintendent who had had only four grades of grammar school. The company paid this student's fee and he was the first one to complete a course. His average grade for the course was above 80.

Very few students have experienced difficulty with their lessons and only in cases where formulas were used. This was anticipated and when problems are given, straight arithmetic is used whenever possible.

We eliminate prerequisites almost entirely by devoting several of the first assignments to a general review or resumé of the preparatory courses which would be taken by resident students. In other words we have studied the type of students likely to be interested and adapted our courses to his needs.

The amount of work required of the department and the cost has exceeded our expectations. We have kept a fairly close check on the costs and find that a course of fifteen assignments costs approximately $330.00. This includes the instructor's time in writing up the course, the stenographer, stencils, postage and the overhead of the Extension Division.

As a standard fee of $2.50 per credit had already been set for all correspondence courses at North Carolina State College and our courses run from one to three credits, the maximum charge is $7.50 per course. This covers the total expense of the student except the cost of a text book if required and the postage when returning assignments to the college. We estimate our present fees will never cover more than 50% of the cost per course. Our attitude, however, is that we are making a contribution to the ceramic industries.

We have been offering courses for six months and have registered sixty-two students. In view of the known demand for such courses, this is, in our opinion, a poor showing. We attribute this, first, to our inability to reach the men who are interested in such courses with the information that they are available; second, to the impression that the courses are limited to citizens of North Carolina, and third to the fear on the part of many that their preparatory training will not permit them to do the work. The distribution of our students is very wide, nearly every state in the Union being represented, with foreign students in Peru, Australia and Canada.

We have had no opportunity to judge the mortality of our correspondence students. It is a well known fact that mortality among correspondence students is high. We have no reason to believe that we will not strike the average.

Most of the time since starting this work has been devoted to writing courses. With more assistance next year we hope to be able to devote more time to interesting employers in organizing groups who will study these courses at night under supervision. Many more men could be reached through such an arrangement and especially those who are not capable of handling a course alone.

So far we have devoted ourselves to courses of particular interest to men in the heavy clay products industries. We have had as many requests for courses from men in the enamel, glass, pottery and abrasive industries as from the heavy clay. We feel these men should be taken care of and unless some of the other departments undertake the work it is our intention to cover the entire field as rapidly as possible. There seems to be little reason for duplication of effort in this field but there is no reason why each department could not devote its efforts to a particular branch of the industry. We are now covering heavy clay and refractories; there still remains enamels, whiteware, decorated pottery, glass, cements and abrasives.

SCHOOL OF ENGINEERING

North Carolina State College of Agriculture and Engineering, College Extension Division Correspondence Courses

(Ceramic Engineering) (Course 208B)

Kilns and Burning. Assignment I

Required Text.—"Burning Clay Wares" by Ellis Lovejoy, published by T. A. Randall and Co., Indianapolis, Ind., price $7.50.

Assignment.—Chapter I to bottom of second paragraph on page 15—"Clays and Their Mineral Contents."

Supplementary Discussion. Method of Study

This course is a study of the general principles underlying the burning or firing of clay products and the kilns in which the burning process is carried on.

Clay is a mixture of particles of minerals and rock of variable sizes and kinds, or a mixture of crystalloids and colloids. The characteristic properties are first, plasticity when wet and second, durability when burned. Clay is not of constant chemical composition nor of constant mineral composition. Its variability in its composition and physical properties is due to the mode of origin and the material from which it is formed.

The burning of clays brings about certain chemical and physical changes and the student beginning the study of burning or firing should have studied the elements of physics and chemistry or should be familiar with the changes which take place through practical experience.

For acquiring a knowledge of many subjects, such as history, languages, etc., the average student is likely to rely mainly on memory. When the student has committed to memory the statements of the author he feels his part has been performed. In the study of burning or firing the "whys and wherefores" should be considered; in other words, the student, in order to master the subject, must reason things out as he proceeds and should compare the statements in the text with his own observation.

The variability in the composition of clays makes almost every operation an individual problem. For this reason the student may find statements in the text with which his own experience does not agree. It must be remembered, however, that the same basic principles govern in all cases.

In the study of any subject one must be able to see the facts and principles with his mind's eye; that is, visualize them and know them to be true irrespective of any

statement in the text. The understanding of the application of the principles also aid in the appreciation of their significance.

The student taking this course who has not studied physics or chemistry will encounter difficulties where physical and chemical terms are used in the test and will have difficulty in understanding references to physical and chemical reactions. In such cases he can invariably get a simplified explanation from some of his associates, or even from his employer. Such students should not become discouraged over the first few assignments as they are in any case obtaining a great deal of real and helpful knowledge by following the course to its finish, even though their grades on the questions may be unsatisfactory to them.

Read the statements concerning the subject under discussion; read the name of the subject always. Try to interpret the meaning of the subject before attempting to answer the question. If you do not understand the subject, state your difficulty to your instructor. Your instructor can obtain very much better information of your real needs in the course if you are free in stating your difficulties on the recitation sheet.

Remember that the lesson sheets make only the absolute requirements, not the total possible requirements. You will not be injured by doing more than the actual letter requirements of the lesson sheet.

Plan of the Lesson Sheet

A. **Assignment.**—Read the lesson sheet and text carefully before attempting to solve the questions.

B. **Lesson Sheet Suggestions.**—General statement and questions are placed on the lesson sheet. These are intended to assist the student in the interpretation of the subject matter and principle involved. Give careful attention to these. The failure of the student to give attention to this part of the lesson sheet will appear on the later recitation sheets sent in to the instructor.

C. **Recitation.**—All questions or problems on lesson sheets are to be solved and sent to the instructor. It is from this work that the instructor judges the degree of mastery of the subject which the student is attaining.

Be careful to put your recitation work in such good form that you can interpret it easily and show the same courtesy to your instructor. Always leave with each exercise enough space for the comment of your instructor. This is where your personality and his come closest together.

D. **Summary.**—With each recitation send in a summary of the lesson, telling in your own words what it is about.

E. **Personal Problems.**—With each lesson make a brief statement of the difficulties which you meet in preparation of the lesson. This enables the instructor to suggest fittingly for your personal advantage.

Lesson Aids

In order to have a good foundation for the study of the subject of "Kilns and Burning" the student should have a knowledge of the raw material which is to be burned. As most of the students taking the course will be engaged in the clay industry and have at least some knowledge of clays, it will be assumed that a short review of the subject as given in the first chapter of the text will suffice.

One of the things that always makes the burning of clay products a problem is that each clay encountered is a mixture of minerals differing to some extent from every other clay, in fact to make the problem more difficult, each deposit of clay usually presents a varying mineralogical composition within limited areas.

The student should get a thorough understanding of the author's explanation of a flux, a eutectic and a eutectic mixture. It should be noted that the silica and alumina in clays must be considered as fluxes just as are lime, iron and the alkalis.

It is important to remember, too, that the fineness of grain has a very important bearing on the burning characteristics of a clay. Any student who has examined a piece of broken vitrified clayware will have noted that the larger grains of clay often remain practically intact while the fine grains have lost their identity. How much more heat would it have taken to produce a dense body had all of the grains been of the same size as those larger ones?

A curve showing the eutectic points of a mixture of pure lime and pure clay is attached. An average clay or shale may have four or five eutectics, one for the potash and silica, one for the iron and silica, another for the potash, iron and silica and so on for every possible combination, each one occurring at a different temperature. The student who has observed the burning of clay products will get an idea from this as to one of the reasons for kiln marking, which often takes place at temperatures far below the point where the ware is finished.

That clays become viscous in the kiln is shown by the fact that they become misshapen. Viscosity is the "relative resistance of a liquid or solid to force tending to change its form." Example—kerosene is less viscous than black oil, or kerosene has a *low* viscosity (it is thin), and black oil has a *high* viscosity (it is thick).

When a clay reaches a point where some of its ingredients begin to fuse it begins to get less viscous and as the temperature increases the viscosity decreases. If the temperature is carried high enough the viscosity will become so low that the ware will "squat" or slump and eventually melt to a slag.

Questions

1. Is a clay a mineral?
2. What is the common base of all clays?
3. What bases or impurities are always associated with kaolinite in common clays and shale?
4. How are clays converted into shales?
5. What is a flux?
6. What fluxes do we find in clays?
7. What is the minimum fusion point of a mixture of minerals called?
8. Discuss briefly the effect of fineness of grain on burning.
9. Why are heavy clay products, except a few special wares, not burned to complete vitrification or to the point where they show no absorption?
10. Give a definition for viscosity.

Physical Geology. Assignment I

(Geology) (Course 120A)

Required Text.—"Introduction to Physical Geology," by W. J. Miller, published by D. Van Nostrand, New York City, price $3.00.

Assignment.—Chapter III of the text—"Materials of the Earth—Rocks."

Supplementary Discussion. Method of Study

The student will be at some disadvantage in not being able to take some laboratory work, but as the whole outdoors is a geological laboratory he should not fail to observe the various geological phenomena whenever the opportunity offers. Every stream bed, railroad or highway cut, every hill and mountain, lake and seashore has its story to tell.

Every rock outcrop does likewise. In addition to keeping his eyes open and observing geological features when going from place to place the student should take advantage of any opportunity to visit geological museums or laboratories in order to examine collections of rocks and minerals, maps and models. In addition to its general educational value a knowledge of geology is an invaluable asset to anyone who uses natural raw materials.

The student should read the first paragraph under Chapter I and get a clear idea of the definition of geology and its subdivisions.

Although a number of geological facts such as the divisions of geological time and the names of rocks and minerals must be memorized the student must not feel that when he has committed to memory the statements in the text he has fulfilled his part, as in order to master the subject he must reason things out if he is to be able to identify the various minerals, rocks, and formations and their mode of origin. He should constantly compare the statements in the text with his own observations.

Read the statements concerning the subject under discussion; read the name of the subject always. Try to interpret the meaning of the subject before attempting to answer the questions. If the student does not understand the subject, he should state his difficulty to his instructor. The instructor can obtain very much better information of the student's real needs in the course if he is free in stating his difficulties on the recitation sheet.

Remember that the lesson sheets make only the absolute requirements, not the total possible requirements. The student will not be injured by doing more than the actual letter requirements of the lesson sheet.

Plan of Lesson Sheet

A. **Assignment.**—Read the lesson sheet and text carefully before attempting to answer the questions.

B. **Lesson Sheet Suggestions.**—General statement and questions are placed on the lesson sheet. These are intended to assist the student in the interpretation of the subject matter and to explain it more fully where necessary. Give careful attention to these. The failure of the student to give attention to this part of the lesson sheet will appear on the later recitation sheets sent in to the instructor.

C. **Recitation.**—All questions or problems on lesson sheets are to be solved and sent to the instructor. It is from this work that the instructor judges the degree of mastery of the subject which the student is attaining.

Be careful to put your recitation work in such good form that you can interpret it easily and show the same courtesy to your instructor. The instructor cannot take for granted that you understand the question unless you answer it fully. Where a discussion is asked for always cover the subject in such a manner that the instructor will have no doubt as to your understanding it. Always leave with each exercise enough space for the comment of your instructor. This is where your personality and his come closest together.

D. **Summary.**—With each recitation send in a summary of the lesson, telling in your own words what it is about.

E. **Personal Problem.**—With each lesson make a brief statement of the difficulties, if any, which you meet in the preparation of the lesson. This enables the instructor to make suggestions to your advantage.

Lesson Aid

It is important that the student firmly fix in his mind the three great groups of rocks—Igneous, Sedimentary and Metamorphic. Study the characteristics of each

so as to be able to identify them. Also, fix firmly in your mind the principal kinds of sedimentary, igneous and metamorphic rocks as given on pages 36, 50 and 55, and the methods by which they were formed. The origin and mode of deposition of a clay, for instance, will often determine whether it is of commercial value without the necessity of any further tests.

The author's classification and explanation will be easily understood.

Questions

1. Define (*a*) geology, (*b*) physical geology, (*c*) historical geology, (*d*) rock, (*e*) rock formation.
2. Into what three great groups are rocks divided?
3. Discuss the general characteristics of sedimentary rocks. Where are they deposited?
4. Give a classification of the more common kinds of sedimentary rocks.
5. What are (*a*) sandstones, (*b*) shales, (*c*) loess, (*d*) limestones, (*e*) diatomaceous earth?
6. Discuss the general characteristics of igneous rocks.
7. Discuss the modes of occurrence of igneous rocks.
8. What is the meaning of metamorphism? What are the agencies of metamorphism?
9. Give the principal kinds of metamorphic rocks.
10. Is slate derived from igneous or metamorphic rocks?

COÖPERATIVE RESEARCH IN CERAMICS[1]

By A. V. Henry

Recently there has been an agitation to inject into our ceramic schools more phases of an industrial nature, and to stress product rather than materials. Without a doubt, courses were primarily inaugurated in our universities for the definite purpose of aiding the manufacturer, and to be the means of producing better claywares. However, our institutions are seemingly drifting more and more to scientific problems, and since there is a limit to the amount of work that can be given in a four-year period, manufacturing difficulties are neglected. This is due, in part, to a lack of coöperation and a mutual indifference between the school and the producer. The ceramic schools quite frequently create the impression that the only contact they desire is one for donations or material assistance. The scientific investigations conducted in schools, especially as reflected in theses, are, to the manufacturer, somewhat abstract. He is unable to see how these can help him in making better wares. Therefore, he assumes schools and everyone connected with them to be theoretical, and it is with misgivings that he places in them any confidence whatever.

The manufacturer feels that he has done his full duty when he has aided in the establishment of our schools. He does not appreciate the fact that his interest is required continuously in order for the schools to give him maximum benefit. How should this interest be expressed? It probably can be summed up in one word, "coöperation." The schools should receive suggestions from the producer and give their best thought to commercial problems, for, apart from the practical benefit to be derived from such service, they would be affected advantageously by keeping abreast of practical ceramic

[1] Presented at the Summer Meeting, American Ceramic Society, Toronto, Canada, July 9, 1925.

development. Quite often practices in plant control are in use that are not the most efficient and often are not observed by the superintendent who is in daily contact with the conditions prevailing at his plant. Therefore, it is always advisable for any industry to have its methods examined periodically by a disinterested engineer. Here the ceramic engineers, employed by the schools, can be used to advantage.

Manufacturers should welcome students studying ceramics in their factories during vacation periods. By so doing, the student becomes acquainted with commercial conditions and at the same time is placed in a position to specialize in the industry in which he is most interested. The manufacturer also has an opportunity to take part in his actual training and to observe his qualifications before engaging him permanently. The average student has a three-months vacation yearly and normally spends his time in work, mainly for the purpose of assisting himself financially. It can readily be seen that it would be far more advantageous from all standpoints for the prospective ceramist to devote this time in a position where his ceramic knowledge would be broadened. The practice of employing undergraduates would make comparatively easy the problem of acquiring suitable men and would eliminate to a large degree the dissatisfaction often expressed with ceramic graduates.

A very concrete method of obtaining mutual interest and benefit is through the medium of coöperative research. Every community has problems of a distinctive nature, the solving of which would be to the advantage of some corporation or company. In a coöperative agreement, the corporation or company specifies the problems to be considered, sponsors and finances them, and the work is supervised and conducted in the various departments of ceramics. Where the problem is of any magnitude, sufficient ceramic engineers are employed to relieve the department of all but supervisory work. In the past such problems have generally been limited to government bureaus. At present, however, problems are so numerous and varied that the schools can quite properly assume a portion of the burden.

What benefits may the school and the producer expect to derive from coöperative research? The benefits are many and these are factors in the success of our educational institutions. Schools with modern laboratories are now found in most of the ceramic centers and all maintain on the faculty, engineers who are familiar with the materials and conditions that are often peculiar to the section. Due to this specialized knowledge, problems affecting the ceramic industry can be efficiently studied in our department laboratories.

Fire to be kept alive must be continuously supplied with new fuel. It is just as true that the alertness of our instructors must be kept alive to the ever changing science of ceramics by such means as coöperative research. Since the training of our students is dependent upon the training of the instructors, it is essential that they be kept in constant contact with the industry. When practical phases of production are being analyzed in the school, the student is better able to correlate the teaching that he receives with products and practice. The environment is then conducive to a wholesome commercial education. The school becomes a well-rounded combination of class room and work shop.

Considered from the viewpoint of the producer, coöperative research is an economical and efficient method of attacking problems. By this means he not only has well equipped laboratories, in which his plant operations can be simulated and scientifically studied, but also the services of men who are specialists in this work. Anything that helps to improve a school helps to improve the industry, for, after all, the student of today is the producer of tomorrow.

Our schools could well be interested in problems affecting the development of the ceramic resources of our country. The manufacturer has his own difficulties in plant

control and therefore does not concern himself with the more general burden of explorative research. Especially in the South and in the West are there vast deposits of materials of great promise which still lie untouched and unknown. How many of our ceramic engineers are familiar with the extensive deposits of sedimentary kaolin or fullers' earth throughout the South? Probably all of us know in an abstract way that there are such deposits, but few know any of the details concerning them. To throw more light upon these clays, the Ceramic Department of the Georgia School of Technology has recently entered into a coöperative agreement with the Central of Georgia Railway. The sedimentary kaolins found in Georgia in vast beds throughout an area of approximately 5000 miles are being studied to extend their logical use in the manufacture of refractories, whiteware bodies and as fillers for paper, rubber and oil cloth. Prior to the last few years, little has been done to classify these kaolins and to determine which of them is best suited to a definite purpose. Very often Georgia clays have been judged as a whole from experiences had from a single deposit, which probably did not represent the best for the purpose intended. These clays, as well as many others that are easily available in the country, should be better understood, more properly selected, refined and blended. The assistance of the schools, with the coöperation of those interested in ceramic development, can well be used for this purpose. The school, then, not only serves the industry but improves itself.

CERAMIC EXTENSION EDUCATION AT IOWA STATE COLLEGE[1]

BY PAUL E. COX

Introduction

Iowa State College has several extension departments which handle short courses, certain types of night school courses, lectures, exhibitions and other activities that need collegiate direction but which are not any part of regular teaching work. The Division of Engineering has its Department of Engineering Extension, and the ceramic extension educational work is done under the direction of that Department.

Short Courses

For some years there has not been a regularly organized short course in ceramic engineering instruction. There has been no real demand for it, because older men directed the industries of the state and these men had gotten to the stage where the office and sales jobs held their interest. As would be expected a crop of younger men is now out in the plants and the Engineering Extension Department is being asked to supply a definite short course of the type commonly offered by departments of ceramics. Only heavy clay products are manufactured in Iowa, so it is probable that the short course will deal with kilns and driers, scumming, die troubles, lamination troubles, and clay winning equipment, and similar related topics.

While the Engineering Extension Department has sponsored meetings called short courses, these have for some years really been the annual meetings of the Iowa Clay Products Manufacturers Association, though no outsider has been denied admission, and the attendance has always been gratifying.

Since the college was called on for the lecturers, these meetings have been educational, and therefore extension work. Generally the speakers were from the faculty of Iowa State College. Last year the keynote of the meeting was the thing being urged

[1] Read at the Summer Meeting, AMERICAN CERAMIC SOCIETY, Toronto, Canada, July 9, 1925.

by many business men; the lecturers talked on practical economics; an out-of-town speaker talked on "Coaching in Business"; while men on the campus talked on accounting methods, business cycles, letter writing, state resources and like topics. No attempt was made at all to discuss plant problems.

The previous year the talks were all on plant problems, and the Ceramic Department presented the results of tests on washed Iowa screenings used to fire Iowa clay hollow building tile by the system best known as the Boss System. Other papers dealt with management problems in the plant, both men and machines being discussed in several papers.

These statements serve to show how the Engineering Extension Department puts across some teaching work while bringing an important group of Iowa business men to the campus. Certainly there are indirect benefits educationally to these men.

Popular Lectures

For five years the Engineering Extension Department has sent out the writer with a portable potter's wheel and a popular lecture on pottery of interest to the Women's Clubs. The wheel has become so obsolete that few people have seen this device but upward of fifty Iowa towns have had this feature of ceramic extension education carried into their lives.

These lectures have dealt generally with ware of interest to the home makers, both white table ware and ornamental pottery. These lectures dealt, however, with the maximum possible amount of technical matter possible to put across in such gatherings. The reactions should be decidedly favorable to the spread of interest in ceramic education, since few people are at all acquainted with the fact that ceramic engineering instruction work has been organized and has reached middle age almost. Indeed, few people can define ceramic engineering and in most of the fifty Iowa towns a new word became a part of the vocabularies.

In many cases, however, the writer has been invited to talk before business men's gatherings and the wheel was merely incidental to solid discussions of possibilities of Iowa clays and shales for additional uses. In one Iowa town the writer has talked before four business men's clubs and one women's club, and certainly something like 500 persons learned for the first time the breadth of the field of ceramic education and products. It should be grasped that Iowa has not the richness of clay manufacturing plants that some other states enjoy, so that such barn-storming tactics fit the circumstances out this way.

The wheel was specially designed for the work, and can be set on a table, opened up, and put to work in ten minutes after arrival in the lecture place. It might be of interest to note that the "village cut-up" always knows exactly how to run the wheel and on trying clowns the act, and makes the hippodrome ending that leaves good nature.

Visual Instruction

Many of the large clay working, glass working and other ceramic products organizations keep reels of excellent quality in the hands of the Engineering Extension Department and such reels as the Lenox, Inc. film, Mason City Brick and Tile Co. films, certain Ford Motor Co. films and others are always out and being shown by all kinds of clubs, schools and like organizations. Indeed it is difficult to have some of the better of these ceramic industry films for use in work on the campus, because they are so seldom at home. The writer has been surprised to find the interest so great on the part of manual training school teachers in ceramic industry films and it must be stated that the very cordial interest on the part of the Engineering Extension Department staff in the work in the

Department of Ceramic Engineering, the cordial wish for a good-sized department at Ames in the field of ceramic engineering, have contributed to this growth in the use of films on ceramic topics. Certainly manufacturers of clay products could very well add to their advertising by furnishing films on the more spectacular features of their businesses.

Women's Clubs

Out in Iowa as well as in other states the Women's Clubs have staged a very large number of programs on ceramic products. They have done this of their own volition, and any extension work done by the college has been done because some woman has been asked to deliver a talk on some kind of pottery she never saw or heard of and so she wrote to the nearest place she could think of for help. The library at Iowa State College has added a very considerable number of books on ceramics due to this club-woman interest. These books are of course of the type that deal with artistic pottery. A traveling collection of the best of American art pottery goes about and is replenished from time to time, the management of this being done by the women. Many women thus see well-designed ware, properly decorated, and purchase according to their means. Such educational work cannot but increase the demand in all ceramic lines for better ware, and to match up with a fine piece of Newcomb pottery, Rookwood pottery, or Marblehead, or any of the others of the excellent types sent out in this collection, sooner or later a good brick house will result, or a tiled floor or other ceramic products. These women are therefore doing thousands of dollars worth of advertising of the best sort of education in ceramics.

One enthusiastic woman in Des Moines took this interest in American studio and small factory pottery over to Paris and managed to impress the idea on the American colony in Paris. The result is that American ceramic products, not only pottery but all good ware, are being discussed across the water. It is but fair to state that this lady got her interest aroused through Iowa State College extension work.

Iowa State College offers work in modeled pottery to the women of the Home Economics Division, the work being done in the ceramic engineering laboratories. Most of these girls marry, build homes and will surely know fired clay all the better for having made a little of it themselves. They are taught the value of tile, of color due to proper firing of clays, of table service, and as they are working under the direction of a first-rate artist, who specialized in art pottery, they become customers without doubt for ceramic ware of the better sort, and so we look on this activity as an extension activity as well as an activity that yields a credit hour or so for girls taking work in household economy.

Exhibitions

Iowa State College takes an active interest in the State Fair and the Ceramic Engineering Department has always been active in furnishing some sort of educational exhibit. One year a very pretty young woman stuck to the task until she could operate the potter's wheel, and being pretty, skilful and pleasant, the Ceramic Department ran away with the honors. Another year an electric kiln was set up and operated and miniature drain tile were made and fired by a student demonstrator. Since Iowa leads the world in the production of drain tile this feature proved of interest. It should be pointed out that education was the purpose and these demonstrators talked about ceramic engineering and what it stands for, while they got the crowd with the tricks. Similar stunts each year are worked up, with student helpers to do the work. Refractories were featured once, paving brick another time, and so on.

On the campus frequent shows are made when gatherings of farmers are at hand, and efforts are always made to tell strangers by exhibitions, demonstrations, etc., exactly

how important a popular knowledge of the field of ceramic engineering is to all classes of people.

Conclusion

It is safe to state that fully half the effort at Iowa State College is given to what is really extension educational work, in those departments that serve in any way ceramic fields. Not only does the Department of Ceramic Engineering do this but it is ably and heartily supported in many ways.

VOCATIONAL TRAINING IN CERAMICS[1]

By Ross C. Purdy

By vocational training we mean training of the student's mind in the use of knowledge; a practice in application of science fundamentals to the problems encountered in a given job. In contrast with collegiate training, vocational education is of an intermediate grade; it ranks in character and grade with the school intermediate between the grammar and collegiate schools known on this continent as High Schools. A vocational course of classroom and laboratory instruction of high school quality and breadth is directed entirely to preparing the student's mind for a better understanding of the underlying scientific principles of his chosen vocation.

Vocational training need not and very often does not include manual training except in so far as manual exercises are necessary in the laboratory to demonstrate the application of the principles and theories developed in the classroom.

Vocational education may be provided in several forms. The vocational education curricula and schedules differ according to convenience and necessities of the students and the availability of facilities.

Two-Year University Industrial Course

The first classes organized by Prof. Edward Orton, Jr., in 1895, were two-year courses of intermediate grade. The prerequisites for admission to this two-year or industrial course were two years industrial experience or graduation from high school for those under twenty-one years of age and practical experience in ceramics for those over twenty-one years of age. Some there were who took this two-year industrial course who had not completed their grammar school training. It was essentially and in fact a vocational course of instruction in that it prepared men for a ceramic vocation; it was limited to preparing pupils for service in the industries and did not aim to give what is generally called higher education, that of collegiate grade. This short or industrial course was continued successfully at Ohio State University for seventeen or more years and several who are now among the most prominent ceramic technologists were graduates of this two year industrial course and had no other school training in ceramics. Three of the Directors of collegiate ceramic departments in the States had no collegiate training other than this industrial course. It was a vocational course of instruction and the results obtained warrant serious consideration of whether the universities should not again give a two-year industrial course.

Midwinter Two Weeks' University Course

Another scheme for vocational training is that which is known as "short winter schools." Being the originator of this vocational educational scheme and having begun it at University of Illinois where it has been continued successfully,

---

[1] Presented at the Summer Meeting, American Ceramic Society, Toronto, Canada, July 9, 1925.

though intermittently, since 1905, I present it for your consideration with considerable pride and with lots of assurance of its value. I am now associated in manufacturing with a ceramic engineer whose only school training other than in one of these two weeks winter courses at the University of Illinois was in the three Rs at a country school. He is now able to calculate molecular formulas and he has developed charts in process control schemes that involve pressures, volumes and weight relations. He is educated in ceramics; self-educated, it is true, but he got his thought direction and methods in those two weeks of University vocational training.

Other universities on rare occasions have given short winter courses of lectures and laboratory exercises open to any who would enroll. Iowa State College is planning to have such vocational courses. The holding of these short term schools in the winter is recommended for serious consideration by universities. Ceramic organizations should urge and support them. They provide a vocational training to many factory employees who otherwise would have no opportunity to obtain a systematic start in the finding and using of those scientific facts which have applications in ceramics.

Summer Courses

Professor Binns at Alfred University has for several years conducted a vocational school. Classes in the technology and laboratory demonstrations of methods of pottery production have been given in these summer schools. Professor Binns has not made these vocational courses generally known to factory employees, hence the majority of the pupils attending are art school teachers. For any one who intended to have pottery making as a vocation, this summer course at Alfred University would be most excellent.

For the three summer months each year our university ceramic departments are idle. Their overhead charges continue as in the winter months. This piles the overhead charges per pupil onto those who attend during the winter, and to the auditors and to those who are responsible for salaries and current expense appropriations this gives a basis for estimating cost of education per pupil, which, from our point of view, is unfair to the winter pupils. It deprives them of adequate instruction and equipment. If the department overhead could be spread over pupils attending twelve rather than nine months the expense per pupil on the auditor's books would appear more favorably.

The scheme of having two summers of satisfactory plant work as a requirement for graduation from a ceramic department is excellent. This should be a requirement in every ceramic school curriculum. This cares for the boys who are taking the collegiate course of instruction, but it is not they who we are now considering. We are thinking of vocational school opportunity for those who can or will not take the collegiate ceramic course.

Would not the disadvantages, if there are any, of having the two-year industrials in the same classes with the four-year collegiate pupils, be entirely met if the ceramic class rooms and laboratories were made available during the three summer months to those who want the industrial or vocational training? Would not this give service and reduce the overhead charges per pupil? A consideration of this by the universities is seriously recommended.

Correspondence Courses

Prof. Greaves-Walker is the first to inaugurate a correspondence course in ceramics. This is commendable and he should have the hearty support of all ceramic organizations and persons. Should we not council with him on making this correspondence course just as effective as possible? He is now and we hope will continue leading in this form of vocational training, that of giving the men in the plant an opportunity in thought direction and methods of fact finding. We pledge him organized assistance if he will make plans for it.

Foremen Institutes This scheme of vocational training has been successful from the standpoint of the foremen. The Ohio State Board for Vocational Education has three lecturers who give instructional courses in factories and industrial centers throughout the state. The Refractories Manufacturers Association for two years sponsored foremen institutes. Some corporations have their own schools with a full time staff of instructors.

A scheme for a coöperation between universities and ceramic associations on a definite schedule of institute meetings in different ceramic centers is recommended for consideration by both the universities and the associations of ceramic manufacturers. This suggestion is in line with those for university extension in ceramics which Professor Watts will present. If foremen institutes are established and thoughtfully cared for they possibly will result in providing for itinerant ceramic lecturers sponsored by and going out from the several ceramic schools.

High Schools The Smith-Hughes law provides for day-time schools, night schools and part-time schools. If a local school board will provide the room and equipment the federal and state governments will assist in the financing of instruction. A ceramic night school has for two years been operating in Newell, W. Va., under the direction of A. V. Bleininger. The Ohio Ceramic Industries Association has petitioned the East Liverpool school board to establish at once a night school and as soon as possible a day school in vocational ceramics. The State Vocation Educational Board has guaranteed very substantial financial aid. Professor Watts has offered the coöperation of the Ohio State University Ceramic Department. The establishment of a ceramic school in East Liverpool High School is well nigh a fact and the Ohio Ceramic Industries Association is planning to secure similar schools in other ceramic centers throughout the state.

The farmers have taken advantage of the provisions in the Smith-Hughes act with the result that in Ohio alone over $700,000 is spent annually by the federal and state government in university extension in agriculture. The ceramic manufacturers need only to present a claim to the state boards and legislature to secure financial support for vocational education in high schools, in those cities where the ceramic interests can justify the local school board in using city school funds to provide the facilities.

Other schemes for vocational training will suggest themselves by local or group requirements and conditions. Those which we have here considered are:

1. Two-year industrial courses at universities.
2. Midwinter short courses of two or more weeks.
3. Summer schools in universities.
4. Correspondence courses.
5. Foremen institutes.
6. High school courses, day, night and part-time courses.

DISCUSSION ON "AN X-RAY STUDY OF NATURAL AND ARTIFICIAL SILLIMANITE"[1]

N. L. BOWEN AND J. W. GREIG:[2] In the July number of the *Journal* a paper by John T. Norton deals with "An X-ray Study of Natural and Artificial Sillimanite." The "artificial sillimanite" is of course mullite

[1] J. F. Norton, *Jour. Amer. Ceram. Soc.*, **8** [7], 401 (1925).

[2] Recd. July 13, 1925.

($3Al_2O_3.2SiO_2$) and not sillimanite ($Al_2O_3.SiO_2$) at all, and Norton's results confirm Wyckoff's observations that mullite and sillimanite powders give indistinguishable X-ray patterns. Wyckoff's observations to this effect were published by us in the original paper where the compound $3Al_2O_3.2SiO_2$ was first definitely recognized and described.[1] Wyckoff has since extended his studies to individual crystals but his results have not yet been published.

In his conclusions Norton states: "The only other conclusion is that the two compounds are identical and this is in direct contradiction of the accurate chemical analyses of Bowen and Greig. It seems as if the X-ray method of analysis was a more fundamental method of determining the nature of a substance than a chemical method in this particular case because the results are properties of the crystalline phase only, and are not upset in any way by the amorphous glass in which these crystals occur or which they may include." Plainly Norton leans toward the opinion that sillimanite and mullite are identical, and if the above-quoted remarks were an accurate picture of the situation the matter might be allowed to rest there. It is, however, by no means a question merely of the relative reliability of X-ray analysis and chemical analysis. We did indeed give chemical analyses of crystals of mullite by way of confirmation of our conclusions, analyses, which, by the way, were made upon free crystals formed in "pipes" of electric furnace melts and which were determined by microscopic examination to be all but free from foreign contamination of any kind. But the establishment of the fact that the compound of alumina and silica stable at high temperatures (mullite) has the composition $3Al_2O_3.2SiO_2$ did not depend primarily upon chemical *analysis* at all but upon *synthesis*. Working with pure alumina and pure silica we found that the 3:2 mixture was the only mixture that could be induced to form a single, homogeneous, crystalline phase. All other mixtures formed the same crystals, with no variation in their properties, together with another phase representing the excess material, and in this respect the 1:1 mixture was no exception. Such evidence of the composition of a compound is complete and final. It needs no analysis of any kind to support it, though confirmation upon that side can do no harm.

It may be pointed out here that two organizations, the Bureau of Mines Experiment Station at Seattle and the Norton Company of Worcester, working independently of each other and of us upon the *synthesis* of "artificial sillimanite" obtained results that confirm our conclusions. They were unable to explain their results in the light of the belief then current that sillimanite ($Al_2O_3.SiO_2$) was the compound formed, but their difficulties fell away with the appearance of our results establishing the composition of the compound as $3Al_2O_3.2SiO_2$.

---

[1] *Jour. Amer. Ceram. Soc.*, **7** [4], 253 (1924).

The difference of chemical composition between sillimanite and mullite is unquestionably clearly defined. In physical properties they are in many respects remarkably alike, yet in most respects measurably different. The refractive indices differ by amounts that are several times the error of measurement on even very small crystals. In thermal behavior they are quite different. Mullite is altogether unaffected at any temperature up to 1810°C, whereas sillimanite, at any temperature above 1545°C, is decomposed into mullite crystals and a highly siliceous liquid. This fact is remarkably difficult to explain upon any hypothesis of the identity of mullite and sillimanite since it would involve the obvious impossibility of a compound breaking up into itself and something else.

In crystal angles and direction of cleavage mullite and sillimanite approach each other more closely than in any other physical properties. Of all properties these are, perhaps, the most intimately connected with the atomic arrangement. Their X-ray diffraction patterns, which furnish a more direct means of deducing atomic arrangements, are indistinguishable. Must we conclude, therefore, in the face of all the evidence of differences, that they are identical, or should we conclude that they are merely so similar in atomic arrangement that they are scarcely distinguishable in crystallographic properties and indistinguishable in X-ray diffraction patterns?

Geophysical Laboratory,
July, 1925.

A DESCRIPTIVE BIBLIOGRAPHY OF SCUMMING AND EFFLORESCENCE[1]

By F. G. Jackson[2]

Introduction

The words "scumming" and "efflorescence" are often confused in ceramics and are frequently replaced by local terms such as "kiln white," "whitewashing," "petering," etc.

The generally accepted meaning seems to be:

Scumming—The formation on the surface of a ceramic body of a deposit of foreign matter during the process of manufacture.

Efflorescence—The formation on the surface of a finished ceramic ware of a deposit of foreign matter due to exposure to weather.

In the following abstracts from the literature the development of understanding of the various causes leading to these blemishes has been traced.

---

[1] Published by permission of the Director, U. S. Bureau of Mines, Department of Commerce.

[2] Associate Chemist.

Whenever a new thought on the subject has been published, this is given fully below. Otherwise only the nature of the article is given.

A study of the literature begins of necessity with "The Collected Writings of Hermann A. Seger." The small amount of work published previous to his time is now buried in obscurity in inaccessible German trade journals and technical papers. Seger reviewed these and added so much of interpretation and explanation as well as new material that it may well be said that the foundations of ceramics as an exact science were here laid.

The literature since Seger's time has been traced in the following publications. Those marked * have been completely searched through 1924.

List of Publications

Baumaterialienmarkt. Leipzig, Germany.
***Brick.** 407 S. Dearborn St., Chicago, Ill.
***Brick and Clay Record.** 407 S. Dearborn St., Chicago, Ill.
Brick and Pottery Trades Journal. London, England.
Brick Builder, The. Boston, Mass.
British Clay Worker, The. 43 Essex St., Strand, London, England.
Builder's Journal, The. England.
***Bulletin of the American Ceramic Society.** Columbus, Ohio.
***Burning Clay Wares.** By Ellis Lovejoy. T. A. Randall & Co., Indianapolis, Ind.
Canadian Clay Worker, The. 32 Colborne St., Toronto, Canada.
***Ceramique, La.** 84 rue d'Hautville (X), Paris, France.
***Ceramique Industrielle, La.** By A. Granger.
***Ceramic Abstracts.** Columbus, Ohio.
***Ceramic Industry.** 407 S. Dearborn St., Chicago, Ill.
***Ceramist, The.** 170 Roseville Ave., Newark, N. J.
***Clay Record.** Chicago, Ill. (Combined in 1911 with **Brick.**)
***Clay Worker, The.** T. A. Randall & Co., Indianapolis, Ind.
Deutsche Toepfer und Ziegler Zeitschrift. Halle, Germany.
Eidgenossen Materialsprüfunzsanstalt in Zurich. Switzerland.
Engineering News. McGraw-Hill Book Co., New York, N. Y.
German Patents.
Industrial and Engineering Chemistry. 17th St. & Penna. Ave., Washington, D. C.
***Journal of the American Ceramic Society.** Columbus, Ohio.
Journal of the Franklin Institute. 15 S. Seventh St., Philadelphia, Pa.
Keramische Rundschau. Dreystr. 4, Berlin, Germany.
Ohio Mining Journal, The. Columbus, Ohio.
Ohio Valley Manufacturer. (Cannot be located.)
Pottery Gazette, The. 8 Broadway, Ludgate, London, E. C., England.
Revue des Materiaux de construction et de Travaux Publics. 148 Bvd. Magento, Paris, France.
Revue Scientifique.
***Sprechsaal.** Coburg, Germany.
***Tonindustrie Zeitung.** Dreystr. 4 Berlin, Germany.
Thonwaaren Fabrik. Stuttgart, Germany.

* Journals have been checked through 1924.

Trade Journal Review, The. England.
***Transactions of the American Ceramic Society.** Columbus, Ohio.
***Transactions of the Ceramic Society.** Stoke-on-Trent, England.
University of Illinois Bulletins. Urbana, Ill.
Zeitschrift Offentliche Chemie. Plauen i.V. Germany.
Ziegel und Bau Industrie.
Ziegel und Cement. Berlin, Germany.

Abstracts of Literature

The Collected Writings of Hermann A. Seger. Vol. I.

P. 108. A large amount of lime in a clay, containing several per cent of iron, will change the red color ordinarily derived from iron oxide to yellow.

P. 127. Such clays (containing much lime) absorb sulphur compounds freely from fire gases and form calcium sulphate and then the normal red color of iron appears. At a high temperature the red is destroyed and the color returns to greenish yellow. Under reducing conditions calcium sulphate is decomposed at lower temperatures than under oxidizing.

P. 213. Experiments are described where the water in kiln gases was withdrawn, condensed and analyzed from kilns burning wood and gas. "The acids and salts remain in the body or unite with the basic substances of the body as the alkalis, lime, magnesia, ferric oxide, and alumina and bring them to the surface as salty incrustations which later on at a higher temperature are decomposed again more or less and give rise to disfiguring efflorescence or a thin glaze. The alkaline salts are very active in the presence of acids. Ammonium chloride will form other volatile chlorides, thus transporting bases to the surface."

P. 272. The first tunnel drier has just been announced. Seger considers its use fraught with perils.

P. 313. Studying the water-smoking of a gas-fired continuous kiln in which gases from chambers containing ware under fire were drawn over green bricks. He found that the bricks sweated "and every brickmaker knows the consequence. There is produced on the surface a whitish, firmly adhering coating...... On examining the efflorescence with a magnifying glass, it will appear as wart-like or scaly or blistering masses quite similar to those found on air-dried brick and whose characteristics disappear gradually only when the clay has assumed the vitreous condition. Of what nature this efflorescence is has not yet been determined by chemistry. Microscopic examination shows it is not ash, but that it is composed of residues partly crystalline which, at one time in solution, have been deposited by the evaporation of water on the surface of the brick. It may also have been caused by the water taken from the clay in water-smoking. Salts which can do this are plentiful, $CaCO_3$, $CaSO_4$, NaCl, and FeS decomposing to form $FeSO_4$, $Al_2(SO_4)_3$ and $MgSO_4$. Also NH_4 salts, alkali salts, H_2SO_3 and H_2SO_4 are condensed from the fire gases and form soluble salts on the surface of the brick."

P. 351. "All the substances which are taken up from the fire gases are concentrated near the surface, and hence all sorts of colors are often blended, while the color of the interior shows a certain uniformity."

P. 354. Analyses are given of the surfaces and cores of yellow bricks with red surfaces and the amount of remaining calcium carbonate in each is calculated from the amount of sulphuric acid present. The ratio of calcium carbonate to iron oxide is very low in the red parts and high in the yellow.

P. 357. Drying efflorescences mostly occur on bricks with smooth dense surfaces. On rough surfaces and on lean and porous clays the water evaporates from within as well as on the surface and thus the soluble impurities are not brought out. "Since in many cases these efflorescences are produced only in water-smoking, and only when water vapors condense on the brick, they may often be prevented by conducting the water-smoking very carefully."

Efflorescences appearing only after manufacture are classed separately. They tend to destruction of the ware, and consist of sodium bicarbonate, sulphates, especially soda and magnesia, chlorides, etc. There is also the effect of organic growths.

P. 366. He describes the greenish or yellowish green efflorescence due to vanadic acid and says that this can be avoided by reduction.

P. 369. He covers the formation of sulphuric acid on the surface of the ware, the consequent formation of soluble sulphates, and the consequent formation of scum in the kiln, efflorescence in service, and destruction of ware by repeated recrystallization. Reduction during firing is his sovereign prescription.

P. 381–4. Yellow and Green Efflorescence on Brick Fronts. Buff burning clays are well suited for terra cotta but often take on an undesirable color on exposure, becoming yellow to blue green and later brown to black. This is often due to vegetable growth but sometimes is a salt. Dr. Cohn believes it is iron, others have suspected cobalt, Seger proved a green efflorescence on a buff brick was chromium. He reports here a golden yellow coating as vanadic acid. A water extract gave the characteristic color changes.

P. 385. Vanadium Compounds in Lignite Clay. He collected and analyzed a sample of green efflorescence, finding 29% vanadic acid. He has found that reduction at high temperature causes the vanadium to fuse so that it cannot form scum.

P. 396. The use of barium compounds to prevent scum is fully covered. The precipitation of sulphates with carbonate, the need of an excess, and the harmlessness of that excess are shown. With barium chloride non-soluble salts are formed and the excess must be avoided. When large amounts of sulphates are present, barium chloride is not recommended.

1877 Aron, Dr. Salt efflorescence on brick. *Tonind. Zeit.*, **1** [19], 147.

Analysis showed 42% sodium sulphate in a gray scum. This serves at higher temperatures as a flux to sinter the ware. Repeated recrystallization will destroy the brick structure.

1877 Cohn, W. On the artistic coloring of ware. *Tonind. Zeit.*, **1** [26], 207.

Describes experiments on dipping wares in solutions of iron salts before firing and varying firing conditions. Can get red, yellow, or green colors. The presence of lime has a bearing. Samples had green efflorescence which he proved was an iron salt.

1877 Anon. Yellow and green efflorescence. *Tonind. Zeit.*, **1** [47], 378.

Question: what is the nature of it?

Answer: see Seger, *Tonind. Zeit.*, **1** [46], 368. (The original of Collected Writings, I, 381–90.)

1878 Trautwine, Wm. Incrustation on brick walls. *Jour. Franklin Institute* [105], 259.

Studied bricks which effloresced in service. He found magnesium, calcium, and ferrous sulphate in bricks fresh from the kiln. The bank clay contained no carbonates or soluble salts, but lime and magnesia, presumably as silicates, in about the same amounts as in the fired ware, suggesting the inference that in some cases firing may con-

vert all or nearly all of the magnesium silicate to sulphate. The process of firing bricks with coal accounts for this. Coal contains pyrites which burn to sulphurous acid gas. When this gas, air, moisture, and substances having an affinity for sulphuric acid are brought together at high temperatures long sustained, sulphates are formed.

1878 PEMBERTON, H. On the evil effects arising from the use of dolomitic lime in building brick walls. *Jour. Franklin Institute* [106], 52. Reviewed *Tonind. Zeit.*, **3**, 178 (1879).

Efflorescence may be caused by Mg compds. in clay converted to $MgSO_4$ by S from coal. Second, lime in mortar absorbs sulphur from combustion products in the air of cities and forms $MgSO_4$. This is dissolved by rain and concentrated on the surface. This solution makes the mortar fall out. Magnesian lime is much used to make mortar. It is preferred by the brick layer.

1879 ANON. Efflorescence on brick. *Tonind. Zeit.*, **3**, 38.

Question: What are markings on the bricks sent?

Answer: White powder is $CaSO_4 + MgSO_4$. Crystals are gypsum, red-brown scum is iron oxy-hydrate, yellow-green stains are vanadium.

1879 ANON. Cause and removal of white efflorescence. *Tonind. Zeit.*, **3**, 54.

Question: How to remove a white efflorescence from a church when Portland cement mortar was used?

Answer: Wash with dilute hydrochloric acid followed by water.

1879 ANON. Yellow-green efflorescence on brown-coal clay brick. *Tonind. Zeit.*, **3**, 129.

Question: Could not make Seger's test for V work well on yellow-green stains unless very plain ones. Finds most V stains on brick in spring when they have stood out all winter. Is this due to moisture?

Answer: (by Seger) Some V salts are colorless and some are insoluble. Effect of moisture on soluble salts fully explained.

1880 ANON. White scum on red bricks. *Tonind. Zeit.*, **4**, 312.

Scum is due largely to Na_2SO_4 and $MgSO_4$, these both very soluble in hot water, slightly in cold water. If cold water is used to temper and bricks are dried fast in a cold air blast and properly fired (so that during water-smoking they do not become wet again) they will not scum. If dried by heat and little draft they will. Workmen's finger prints on bricks show as scum because the heat of the body has dissolved the salts.

Answer: $CaSO_4$ also plays an important role in scumming. Solubilities quoted. Maximum solubilities around 35°C. Finger prints cannot be due so much to temperature as to pressure and oil on the fingers.

1880 ANON. White scum on red bricks. *Tonind. Zeit.*, **4**, 422.

Question: Water-smoking seems unequal in different parts of kiln. Resets put in unfavorable places will scum. What is this and how prevent it?

Answer: Principally calcium and magnesium sulphates formed by condensed water and acids in smoke. Draw plenty of air through the kiln, have no dead air pockets and heat slowly.

1885 ANON. White scum on brick. *Tonind. Zeit.*, **9**, 378.

Question: Brick from ring kiln burning hard coal are almost always scummed. I want to try peat. Will it help?

Answer: Scum is due to condensed moisture on ware. Can be prevented with care. Peat contains more water, therefore needs more care.

1886 SEGER'S LABORATORY. Analysis of effloresced salts. *Tonind. Zeit.*, **10**, 400.

Sample showed

K_2SO_4	32.38	water soluble
Na_2SO_4	26.83	
$CaSO_4$	0.60	
$CaCO_3$	5.32	acid soluble
$Fe_2O_3 + Al_2O_3$	0.52	
Insoluble residue (sand)	34.35	

1886 EDITORIAL. Efflorescence on brick. *Clay Worker*, Jan.

"We have little disposition to enter into discussion of the many papers being published on this subject. We desire, however, to publish the several theories, observations, and experiments that come to hand and avoid injury to any but aid in the truthful solution of the real cause or causes.

"The following was read by J. C. ANDERSON before the Illinois Society of Architects:

" 'The substances of this wall coating I find to be essentially the sulphates of magnesium, soda and potash. These do not come from the face brick; this applies to several makes; the main cause of the evil lies in the magnesia in the lime of the mortar.

" 'The common bricks are made from drift clays containing pebbles high in magnesia and iron pyrites. The face bricks are from a clay containing little of these. In firing common bricks the sulphur is eliminated and converted into sulphuric acid and absorbed by the brick at a red heat. It unites with the alkalis and alkaline earths, forming salts. These bricks are saturated with water before laying. In drying, the salts are carried through the face brick to the outside and crystallize there.' He advises pure mortar for face bricks, isolating the front wall from the rear wall, using as little water as possible in construction, protecting from rain during construction, and use of projecting drips.

"Wm. E. HINCHLIFF replies to this in the *Chicago Tribune*, Dec. 11, 1885 (?):

" 'I will agree with the gentleman when he says that this subject has received little notice in this city until 'very recent years' for there was no problem here until the Anderson Pressed-Brick Co. began to manufacture. The trouble is in his clay which shows magnesia in plenty.' Disclaims A's championship that deposits are restricted to no particular brick. Some may show it and it is their fault. Why are Anderson bricks covered with whitewash oftentimes before leaving his yard or even his kiln if the trouble is with the mortar? This has been seen by many witnesses. Differs also as to remedies. Advises painting the bricks.

"F. P. MAYERBERG writes to the *Clay Worker:*

" 'Mr. Anderson should have said 'The evil is in existence since insufficiently burned brick made of heavily charged alkali clays were laid in walls exposed to all changes of weather.' All of the prominent terra cotta manufacturers have met the same trouble and overcome it. Their process is too expensive for bricks, but there are cheaper ways of doing it.' "

1886 BROWN, R. T. The composition of whitewash. *Clay Worker*, **6**, 325.

"The white substance that appears on the surface of new brick buildings is carbonate of lime. Lime may exist in clay and not be visible. When it is burned it becomes caustic lime, soluble in water. When the brick absorbs water from the rain, the lime dissolves and is carried to the surface on drying. There it takes carbonic acid from the air and becomes insoluble carbonate. It may be washed off with dilute hydrochloric (muriatic) acid. I know of no way to prevent its appearance, if the clay contains lime."

1887 ANON. Whitewashing of tile. *Clay Worker*, **8**, 175.

"We have received a tile from Mogadore, Ohio, that is heavily whitewashed where fingers touched it while soft. They ask why. We do not know. The whitewash is carbonate of lime or saltpeter or soda deposited in the process of water-smoking."

1888 Lovejoy, Ellis. Clays of Fivemile Creek. *Ohio Mining Journal*, **17**, 34.

"Some of these clays effloresce in service very badly. Analysis shows the efflorescence to be sulphate of alkalis with iron and traces of calcium and magnesium sulphates. Explanations previously offered: (1) Sulphur fumes in smoky air from sulphates. (2) Sulphur fumes from burning soft coal in kiln form sulphates. These do not explain why when bricks made from two different clays are fired in the same kiln one kind effloresces and the other does not. Sulphide of iron has been found in some of these clays. When this is fired in an oxidizing atmosphere, it forms alkaline sulphates which are the cause of the efflorescence."

1888 "Bachstein Macher." To beginners in clayworking. *Clay Worker*, **9**, 23.

"Many bricks are discolored by setting them too wet into the kiln. It will pay you if you set them dry into the kiln."

1888 Baker, Prof. Ira O. Efflorescence and impervious mortar. *Engineering News*. Reprinted in *Clay Worker*, **9**, 286.

The efflorescence sometimes originates in the brick, particularly if they are fired with sulphurous coal or are made from a clay containing iron pyrites. When the brick gets wet the water dissolves the sulphates of lime and magnesia and leaves them on the surface. Frequently the efflorescence on the brick is due to the absorption of impregnated water from the mortar.

1888 Davis, Chas. T. Exudations upon brickwork. *Clay Worker*, **10**, 278.

Description of appearance and occurrence during wet weather. Repeats explanations already brought forth.

An epidemic of efflorescence in 1882 was discussed at length by members of the Academy of Natural Sciences in Philadelphia. They decided it was sulphate of magnesia formed from magnesia in the mortar dissolved in the presence of water by sulphurous acid from burning coal.

1889 Elsom, J. F. Efflorescence on brick, its cause and cure. *Clay Worker*, **11**, 18.

A long paper read at the N. B. M. A. convention. Nothing new offered. Discussion brought out that red mortar makes more efflorescence than other colors and buildings put up in wet weather will effloresce badly. Hard-fired bricks effloresce less than soft-fired, rough brick less than smooth.

1889 F. L. H. Touching on efflorescence. *Clay Worker*, **11**, 238.

Attributes efflorescence to dampness in kiln.

1889 Bluck, R. S. What's the trouble? *Clay Worker*, **12**, 95.

Wants to make a red face brick but gets a very thin greyish-white skim on it. Would like a remedy.

1889 Cabot, Samuel. White on bricks. *Builder and Woodworker*. (Reprinted in *Clay Worker*, **12**, 98.)

Finds at least three substances which cause this, carbonate of soda, most common on new work, silicate of soda from salt clays, and sulphate of magnesia. This is formed from pyrites in clay forming sulphuric acid and this uniting with magnesia in the lime mortar. He concludes: "Efflorescence is never due to bricks alone and seldom to lime alone. To avoid it the bricks should be covered with an oily preservative. Linseed oil will not serve."

1890 Crary, J. W., Sr. Water-smoking and reburning kilns. *Clay Worker*, **14**, 262.

All clays that shrink or settle in firing have more or less alkaline salts. If heated too fast or made red hot on the surface before the water is out of the inside part of the

brick the salts effloresce. If the kiln be closed too quickly, or until the whitewash be thoroughly oxidized or burned off, the bricks will have a discolored, motley appearance.

1892 ANON. Efflorescence on brick. *Clay Record,* **1,** 47.

New buildings in Chicago are effloresced. Smoke has much to do with it. Alkali is absorbed by porous brick. Efflorescence results when brick are made from a clay containing magnesium, sodium or potassium sulphate and not sufficiently fired to fuse them. The sulphates dissolve the alkali on becoming wet. On evaporation the white crystals are deposited. Describes tests made at Berlin on brick to determine if they will effloresce.

1892 J. F. E. Efflorescence on brick. *Clay Record,* **1,** 82.

Answer to above. Efflorescence contains carbonates, sulphates, silicates, etc. Generally one predominates but not always the same one. For many causes there can not be one cure. Cause may be in the clay, the brick, the mortar, the season, manipulation, laying. Describes how mortar should be prepared. Advises seasoning it a year.

1893 Discussion at N. B. M. A. convention on whitewashed bricks. *Clay Worker,* **19,** 163.

Question: Will hot air in a drier cause whitewash?

Answer: It was found out nine years ago that $BaCO_3$ would prevent it. Does not know why. Brick set wet in kiln will whitewash. Some very vague ideas expressed as to the theory.

1893 ANON. Efflorescence on brick. *Clay Worker,* **19,** 509.

Advises to do nothing about it but to build the building fairly watertight and it will not give much trouble or last long.

1894 ANON. Discoloration of brick. *Clay Record,* **4** [10], 18.

The writer's common bricks scum. He is water-smoking with wood and firing with three different sorts of coal but cannot prevent scum. Wanted help from N. B. M. A. convention. Proposed a question and is dissatisfied with the answers.

1894 ANON. Efflorescence on brick. *Clay Record,* **4** [12], 27.

Bad cases in Philadelphia after a hard winter and heavy spring rains. Paint and oil suggested to prevent recurrences.

1895 EDITORIAL. Whitewash and efflorescence. *Clay Worker,* **24,** 352.

A plea for investigation of these subjects.

1895 CRAMER. Color appearances of brick when water-smoking, also from artificial drying. *Brick,* **2,** 44. (Translated from *Tonind. Zeit.*)

Drying by direct heat has changed the color of some yellow bricks to gray. Sulphurous gases on wet clay are blamed. Olschewsky says in discussion much trouble comes from drier, not from kiln and much $BaCl_2$ and to $BaCO_3$ is used to the wrong end.

1895 CUMMER, F. D. Reply to above. *Brick,* **2,** 49.

C. did not mention that ware must be wet to have sulphur in drying gases absorbed. Large volume of air should be mixed with kiln gases. This, moving fast, will not allow condensation and corrosion. The writer makes a direct heat drier on this principle which works successfully. He can dry a terra cotta block weighing $15^1/_2$ lbs. wet to 10 lbs. dry in 36 hours without cracking.

1895 OLSCHEWSKY, W. Prevention of scum and discoloration on face bricks, terra cotta, etc. *Ziegel & Cement.* (Translated in *Clay Record,* **9** [10], 16 (1896.)

Translated by Huelsen & Co. as "Petering" or "Whitewashing" in a pamphlet published at Newcastle-on-Tyne. (Reviewed in *Brick,* **2,** 278.)

Gives the following limits:

1. When mainly so-called finger dints are scummed, suspect the water.

2. If scum is all over the face, see if the side against the board in drying is clean. If so, trouble is in clay.

3. If scum only when exposed in kiln or drying, then due to salts in clay, but likely only small amounts.

Barium carbonate will precipitate calcium sulphate.

1895 BENFEY, GUSTAV. Discoloration of face brick and terra cotta. *Brick*, **2**, 358.

Describes occurrence of gypsum and how only a little is dissolved if worked fast. Describes use of $BaCO_3$ and of flour paste (formerly used). Epidemic of whitewash in Chicago blamed on soluble salts washed out of soot on buildings into bricks by a thunderstorm. Citizens had blamed lightning. Describes normal efflorescence on new buildings.

1896 EDITORIAL. Efflorescence on Brick. *Clay Record*, **9** [10], 11.

Opens the subject.

1896 EDITORIAL. Prevention of scum on face brick. *Clay Record*, **9** [12], 19.

Describes and urges use of $BaCO_3$.

1896 DISCUSSION N. B. M. A. convention. "Can brick become stained white or deposit an efflorescence after burning owing to sulphurous coal?" *Brick*, **4**, 87.

Mr. Fiske says sulphur in coal may make the white found on the bricks as they come from the kiln but does not think it has anything to do with efflorescence in the wall. Mr. Ittner agrees.

1896 DISCUSSION, N. B. M. A. convention. "Does slow drying tend to prevent discoloration or whitewashing during burning?" *Brick*, **4**, 89.

MR. ITTNER: "Slow drying is conceded to be ample drying. Thorough drying will prevent discoloration unless it is in the clay."

CAPT. CRAFTS: "If there is scum we say that they were set too wet."

MR. RICHARDSON: "You must not let moisture deposit on the brick at all. Must have a strong draft."

1896 ANON. "Hodge-Podge." *Tonind. Zeit.*, **20**, 588.

Describes efflorescence on walls. Ascribes either to plants (algae) or minerals. Effect of slightly soluble salts lasts longest. Sulphates are the commonest, then carbonates, chlorides, nitrates. Vanadium and molybdenum salts are prominent because of intense green color. Possible sources tabulated. Describes methods of formation of salts and their efflorescence.

1896 OLSCHEWSKY, W. Drying clay wares. German Pat., **87**, 103.

Wares dried in a closed room by $CaCl_2$. $CaCl_2$ solution drains off, is evaporated and used again.

1897 DISCUSSION, N. B. M. A. convention. "Is efflorescence on a brick wall ever due to the kind of mortar used?" *Brick*, **6**, 118.

ORTON: "Red mortar is colored by iron oxide made from copperas (ferrous sulphate) by igniting. The action is not complete and the remaining $FeSO_4$ effloresces."

1897 DISCUSSION, N. B. M. A. convention. "Can whitewash be prevented from coming on the surface of green brick by varying its treatment in a drying tunnel?" *Brick*, **6**, 118.

Orton said he knew of at least four causes. Matter referred to an investigating committee.

1897 DISCUSSION, N. B. M. A. convention. "What is the composition of efflorescence?" *Clay Worker*, **27**, 124.

ORTON: "It is a soluble salt, generally of lime. It is carried to the surface by water in drying. The faster the drying the more efflorescence. There are four or five sources from which it may come."

GATES: Advises slow raising of temperature at first so as to avoid condensation. Sulphur from the fires will adhere to that and burn on it as a scum.

1897 JACOBS, H. L. Water-smoking and its effect on the brick. *Clay Worker*, **28**, 101.

Advocates use of draft in water-smoking.

1897 ANON. Brick efflorescence. *Clay Worker*, **28**, 265.

Prof. Gunther said in an address that efflorescence or incrustation could be prevented by long exposure of clay, by adding barium salts before burning or in continuous kilns by preventing oxidation of sulphur by limiting the air supply.

1898 ANON. Efflorescence on brick and sandstone. *Trade Jour. Rev.* (Reprinted in *Clay Record*, **13** [1], 15.)

Review of subject.

1898 PEMBERTON, HENRY. Discussion of efflorescence. *Trade Jour. Rev.*, **106**, 52.

Blames dolomitic lime acted on by sulphur in smoke in the air.

1898 ANON. A German's opinion of brick efflorescence. *Clay Record*, **13** [7], 19.

A review of Seger's work. Advises $BaCO_3$, reduction and high fire.

1898 GERLACH, O. Saline efflorescence, its cause. *Clay Record*, **13** [8], 16; **13** [9], 16.

A long article. Considers efflorescent sulphates found in clay, oxidation of pyrite to sulphate. Less scum if clay not weathered. Green ware should not stand around. Gypsum in water used. Colorants may bring in sulphur. Drying should be rapid but complete. Kiln scum due to pyrites in ware and coal. Hygroscopic water recondenses in cool parts of kiln and increases drier scum. May contain H_2SO_4 and make more sulphates. H. Guenther has shown that FeS_2 burning forms whitewash. Gerlach does not consider water necessary for this action. Reports six experiments to show that FeS_2 in clay or fuel converts $CaCO_3$ in clay to $CaSO_4$.

1898 FREY, F. E. Efflorescence (whitewashing) of brick. *Clay Worker*, **30**, 105.

Reviews causes. Advises blaming the mortar if possible.

1898 CARSON, J. W. Whitewash and fingermarks. *Clay Worker*, **30**, 120.

Describes common plant troubles.

1898 ANON. Scummed brick. *Brick*, **8**, 56, 187.

Answers to questions on scummed brick.

1898 EDITORIAL. *Brick*, **8**, 165, 222.

Reviews of subject.

1898 EDITORIAL. Witherite. *Brick*, **9**, 32.

Review of its use.

1898 EDITORIAL. Use of $BaCO_3$. *Brick*, **9**, 172.

Advises use of precipitated material.

1899 ANON. Some interesting history of petering of brick walls. *Brick*, **10**, 195.

Goes back to third Napoleon.

1899 SCHALL, S. P. Can discoloration of brick be prevented? *Brick*, **10**, 212.

Describes firing tests with different amounts of $BaCO_3$ as sold by him.

1899 GERLACH, DR. OTTO. On the saline efflorescence of brick. *Brick Builder*, for 1899.

Clearly states the possibility of a reaction between the lime of the brick and the sulphur in the kiln gases to make soluble sulphates.

1899 ANON. Questions and answers on scum. *Brick*, **10**, 252; **11**, 38.

1899 ANON. Description of German plants. *Brick*, **11**, 58.

Cases of efflorescence referred to.

1899 ANON. What makes the white come out on brick walls? *Ohio Valley Manufacturer*. (Reprinted in *Clay Worker*, **32**, 112, and *Clay Record*, **14** [12], 21.)

Review of the question. Advises use of $BaCO_3$.

1899 ANON. Scum or efflorescence. *Clay Record*, **15** [6], 21.

Due to soluble salts in clay, generally sulphates. Reduction at high temperatures best to remove.

1899 ANON. Discoloration of brick work. *Clay Record*, **15** [12], 17.

Review of an article by H. Guenther. Causes given. $BaCO_3$ advised.

1899 ANON. Brickmaking in Yorkshire. *Brick*, **10**, 232.

Face bricks are fired with faces butted so they will not scum. Ends are tarred. In Leeds efflorescence is universal and quality of bricks is very poor.

1899 DISCUSSION, first meeting of the AMERICAN CERAMIC SOCIETY. *Trans. Amer. Ceram. Soc.*, **1**, 104.

The following points were brought out:

1. Kiln scumming occurs more often in the bottom of the setting of a down-draft kiln than in the top.
2. Scummed bricks are harder than adjacent ones in the kiln that are not scummed.
3. Scummed paving brick give good service.
4. Scumming is due to the presence of sulphate of lime.

1901 OGLE, E. M. Unweathered vs. weathered clay. *Trans. Amer. Ceram. Soc.*, **3**, 171.

Drew out Orton on the chemistry of conversion of sulphides to sulphates during weathering.

1901 BROWN, A. E. The drying of ceramic products. *Pottery Gaz.* (Translated in *La Ceramique*, **2** [3], 132.)

Transport of soluble salts to surface the greater the slower the evaporation. Scum can be diminished or prevented by sprinkling the surface of the brick with sand. This makes a dry surface and the salts are deposited inside the brick. This can also be done by causing rapid evaporation at first. Applying a thin coat of flour paste makes the salt deposit on it instead of on the ware.

1902 SEGER AND CRAMER. Prevention of scum. *Tonind. Zeit.*, **26**, 218.

Bricks have been known to scum although the soluble salts in the clay were precipitated by barium addition. This is because soluble salts are made in firing and excess barium salts rendered insoluble as silicates. To prevent this the fired brick should be dipped in barium nitrate or chloride solution. This will precipitate calcium sulphate. Patent applied for.

1902 ANON. Efflorescence on decorated biscuit. *Sprechsaal*, **35**, 1020.

Question: My porcelain biscuit effloresces after it has been decorated and fired. I use only good materials and fire to cone 13–14. How can this be prevented?

Answer: It is hard to answer without more details. Adding a little calcite may help.

1902 ANON. Prevention of discoloration and scum on terra cotta. *Clay Record*, **21** [7], 13.

Long review of known methods written for the practical man.

1903 ORTON. On the rôle played by iron in the firing of clay wares. *Trans. Amer. Ceram. Soc.*, **5**, 377.

Expounds the decomposition of pyrite.

1903 ANON. Efflorescence on bricks. *Zeit. für. öff. Chemie.* (Reprinted in *Tonind. Zeit.*, **27**, 512.)

Describes a serious case of $MgSO_4$ efflorescence during construction of a building. Tests on stock showed more salt in hard burned than in soft burned.

1903 KOCH, J. J. Water-smoking and whitewashing. *Clay Worker*, **40**, 452.

A careful and thorough presentation of the subject.

1903 DE JOANNIS, H. How to overcome the effects of alkali most cheaply in common brick. *Clay Worker*, **39**, 49.

A review of literature and a well-put presentation of the whole subject.

1903 ANON. Brown crusty scum on tile. *Sprechsaal*, **36**, 674.

Question: Has a brown efflorescence on tile. What is cause and how can it be prevented?

Answer: The crust comes from soluble iron salts from pyrite in the tile.

1903 ANON. Efflorescence on glaze. *Sprechsaal*, **36**, 87.

Question: What is the trouble when whiteware shows an efflorescence on the glaze like mildew?

Answer: Too much soda.

1903 ANON. The prevention of scum and discoloration. *Brick*, **18**, 8.

Article extolling the use of $BaCO_3$ and $BaCl_2$.

1904 MÄCKLER, DR. H. The efflorescence of brick work, its cause and prevention. Pamphlet from *Tonind. Zeit.* press.

A thorough presentation in the form of twenty questions and answers. Describes the tests used in Berlin to see if bricks or mortar will effloresce.

1904 MÄCHLER, DR. H. Further investigations of the efflorescence of bricks. *Tonind. Zeit.*, **28**, 436.

Decides that chemical analysis is not an infallible guide to whether a brick will effloresce. $MgSO_4$ and Na_2SO_4 cause efflorescence, K_2SO_4 and $CaSO_4$ do not. Efflorescence may last several years and then disappear. Has made a study of the relation between the amount of soluble salt in a brick, the amount of efflorescence that can be induced, and the size of the pores.

1904 ANON. Perfect color of brick. *Deutsche Toepfer und Ziegler Zeit.* (Reprinted in *Clay Worker*, **42**, 29.)

Soluble salts in raw materials spoil color by crystallizing on the surface, principally sulphates of calcium, magnesium, and the alkalis, also vanadium salts on light colored bricks. A long, well considered article.

1904 ANON. Afflicted with scum. What is the remedy? *Clay Worker*, **42**, 154.

A request for help on scummed paving brick.

Answer: Increase draft on drier or during water-smoking.

1904 ANON. The scum trouble overcome. *Clay Worker*, **42**, 266.

Trouble mentioned in above article has been located and scum stopped.

1904 Hirsch, H. Clay and salt solutions. *Tonind. Zeit.*, **28,** 231.

Clay in suspension can adsorb salts in solution. This can be prevented by adding aluminum chloride. This is of importance in determining the sulphates and soluble salts in clays.

1904 Hirsch, H. The "practical" test for amount of $BaCO_3$. *Tonind. Zeit.*, **28,** 491.

While he did not understand the cause of the excessive taking up of barium he found a means of combating it. If 4% $AlCl_3$ be first added, the determination of the amount of $BaCO_3$ necessary to prevent scumming will be faultless.

1904–6 Perkiewicz. Protection against efflorescence and the effect of smoke action. *La Ceramique,* **2** [6], 145; [7], 41; [7], 70; [9], 54; [9], 55. (Reprinted in *Tonind. Zeit.*, **28,** 819; **28,** 1604; **29,** 187; **30,** 509.)

A series of articles and patents on a protective coating to be applied to clay wares before firing. The scum is supposed to form in the coat and fall off with it during firing. First flour paste or dextrine proposed. Then a mixture of glue and slip. Then glue and farina and an antiseptic. Machine evolved for applying the coat.

1905 Lovejoy, Ellis. Dry-pressed brick. *Trans. Amer. Ceram. Soc.*, **7,** 232.

Described early efforts to combat efflorescence. (See his 1888 article, p. 382.) It was first thought that efflorescence of bricks was due to alkalis but analyses showed that the clay with the least alkali effloresced badly. Then a miner brought a bunch of roots from a clay bed in which the carbon had been replaced by pyrite. Lovejoy began to test for sulphur in clay. He then learned not to weather clay, why crop clay was dangerous, why alkali was not related to scum. They hurried their clay right through to the kiln, roasted out the sulphur before it could oxidize, fired it hard, and guaranteed no efflorescence.

Barium carbonate will not serve on dry-pressed ware. There is not enough water to dissolve it. Barium chloride is far less dangerous than in other processes on this account. The stiff mud process meets its trouble in the drier and to a greater degree than the dry press. Solution takes time. Quick drying and barium are the only remedies now known. Barium best added with the water in the wet pan or pug mill. There is a "kiln white" or scum which comes on the bricks in the kiln and concerning which we have little knowledge and no solution. The use of wet dirty sulphurous coal and wet ware in the kiln tend toward its formation. It occurs on exposed surfaces. That it is a sulphur compound we are reasonably certain, but that it comes from the clay we are not so sure. It is always worse toward the bottom of the kiln. The only remedy is clean dry coal.

1905 Granger, A. "La Ceramique Industrielle." Page 31.

"Calcium sulphate is also found in clays, if the body is soft burned, this is only dehydrated and rehydrates in moist air, penetrating the body. This diminishes the solidity. At high temperatures the sulphuric anhydride is volatilized and the base combines with the silica. Calcium sulphate may be formed in firing, if the base is calcareous, from coal rich in pyrite. It produces then the accidents which we will enumerate."

Ibid., Page 207.

"Soft coal used for firing ceramic products is a long flame coal. It should be as far as possible free from pyrite. A sulphurous coal gives in burning sulphur compounds whose presence is objectionable in certain cases."

1905 Mächler, Dr. H. Further investigations. *Tonind. Zeit.*, **29,** 437.

Experiments on adding known varying amounts of salts to clays and making bricks. Pore space varied. Results rather indefinite.

1905 Anon. Black efflorescence on doll's heads. *Sprechsaal*, **38**, 1516.
Question: Dolls' heads show sometimes a black efflorescence after glost firing.
Answer: Bisque fire should be hotter.

1906 Anon. *Brick*, **25**, 166.
Account of a suit over cleaning the scum from a brick building.

1906 Smith, S. Efflorescence on brickwork. *Brick and Pottery Trades Jour.*, **13**, 110. (Reprinted in *British Clayworker, Suppl.*, **14**, 95.)
Review of the subject.

1906 Franche, G. Saline efflorescence on bricks. *La Ceramique*, **9**, 105.
$CaSO_4$ blamed for all the trouble. Discusses relative advantages and costs of (1) addition of $BaCO_3$, (2) coating with flour paste and (3) removal of the diseased surface by a method not described.

1906 Kleiber, J. Iron pyrite in clay and coal and its damaging effect on the ware. *Tonind. Zeit.*, **30**, 754.
Describes decomposition of pyrite with heat and evolution of H_2SO_4 and formation of low melting iron silicate. Recondensation of sulphuric acid in the ring furnace. Formation of calcium sulphate from a limey clay, formation of scum, change of color.

1906 Seger and Cramer. Several causes for efflorescence on brickwork. *Tonind. Zeit.*, **30**, 1752.
Some rooms in a building had scummed, others had not. Bricks, mortar and water tested all right. The rooms had been dried by a fire burning high sulphur coal and the sulphur had attacked the walls.

1906 Anon. Formation of sulphates in bricks and the cause. *Tonind. Zeit.*, **30**, 2014.
Absorption of sulphate from kiln smoke may be by alkalis and magnesia as well as lime. The alkaline sulphates are easily decomposed, magnesium sulphate less easily. If lime is present it takes the sulphate from the others. Calcium sulphate is decomposed only at high temperatures. Therefore hard-fired ware may contain more sulphate than soft-fired.

1906 Lovejoy, Ellis. The use of barium compounds in preventing scums. *Trans. Amer. Ceram. Soc.*, **8**, 255 (1906). (Reprinted in *Clay Worker*, **49**, 668 (1908). *Tonind. Zeit.*, **32**, 1354 (1908).)
Calcium sulphate the chief source of trouble. Discussion confined to it. Seger gives solubility of one part in 386 to 451 parts of water depending on temperature. Scums classified as "wall," "kiln," and "drier." Last only discussed. Generally calcium sulphate. By calculations of amounts dissolved he shows why the little water in dry-pressed ware is less apt to cause scumming than the four times as much in stiff mud bricks. The better circulation of water there is, the better $BaCO_3$ will precipitate $CaSO_4$.

$BaCl_2$ will precipitate $CaSO_4$ but leaves a soluble $CaCl_2$ and excess $BaCl_2$ is soluble. An insufficient amount might help with $BaCO_3$ as well.

Barium acid carbonate suggested, half as soluble as $CaSO_4$.

Barium hydrate would be better, very soluble but unstable. Carbonate could be partly converted and used at once. Excess hydrate would become carbonate.

1906 Jones, J. C. Efflorescence on brick. *Univ. of Ill. Bull.*, **4**. (Reprinted in *Trans. Amer. Ceram. Soc.*, **8**, 369. Advance notice, *Clay Record*, **28** [12], 30. Reprinted **31** [4], 24 (1907).)
Gives history and classification. He made trials of 0.5% each of $CaSO_4$, $MgSO_4$,

$Al_2(SO_4)_3$, $CaCO_3$, Na_2CO_3, NaCl and fired oxidizing. Sulphates scummed much the worst. Gives a very good review of the knowledge to date. Studied and explained a number of typical cases of wall scumming and gives methods of prevention. Gives a bibliography.

1906 ANON. Scum prevention. *Brick and Pottery Trades Jour.*, **14**, 37.
Question: Should I change from $BaCO_3$ to $BaCl_2$?
Answer: No.

1906 ANON. A simple scum preventive. *Brick and Pottery Trades Jour.*, **14**, 75.
Cover articles with tar, oil or starch paste.

1906 ANON. *Brick and Pottery Trades Jour.*, **14**, 147.
Question: Is there anything better than witherite?
Answer: Precipitated barium carbonate.

1906 ANON. Anti-scum paste. *Brick and Pottery Trades Jour.*, **14**, 251.
Question: Formula?
Answer: Starch and glue boiled.

1906 ANON. Efflorescence in the muffle kiln. *Sprechsaal*, **39**, 1336.
Question: Blue overlaid on a white matt glaze changes to black and some white spots show. Black points appear at some places.
Answer: Due to reduction.

1906–7 MELLOR, J. W. The determination of the amount of soluble salts in clays. *Trans. Ceram. Soc.* (Eng.), **6**, 54.
"Scumming is due to soluble salts."

1906–7 MELLOR, J. W. The sulphuring and feathering of glazes. *Trans. Ceramic Soc.* (Eng.), **6**, 71.
Describes the action of SO_3 from coal on glaze to form sulphate crystals.

1907 ANON. Efflorescence on sand-lime brick. *Tonind. Zeit.*, **36**, p. 1907.
The trouble was traced to ashes and cinders dumped in storage yards.

1907 LEDUC, E. The efflorescence of brick. *Rev. Mat. Cons. Trav. Pub.* (Translated in *Brick*, **26**, 300.)
A long article telling the story from the beginning and giving the German methods of testing to determine the right amount of $BaCO_3$. Tests the relative value of barium chloride, aluminate and carbonate as a preventive. Diagrams of testing apparatus.

1907 LOVEJOY, ELLIS. Scumming and efflorescence. Pamphlet printed by F. J. Heer, Columbus, Ohio.
This 60-page pamphlet attacks the problem in a business-like way and coördinates all the scattered information on the subject. Troubles from all possible sources are classified and distinguished from each other and the proper remedies for each are indicated.

1907 FRANCHE, M. Process to suppress efflorescence and spots from ceramic products. *La Ceramique*, **10**, 58.
A mechanical process as follows:
1. A sand blasting of the fired ware.
2. A material and arrangements appropriate. Gives description of sand blasting arrangements.

1907 Zschokke, B. On the action of different mortars on the efflorescence of masonry. *Eidgenossen Materialsprüfungsanstalt in Zurich,* No. 11, p. 217. (Translated in *La Ceramique,* **10,** 93.)

A long historical descriptive article ending with some tests of actual salts made up in bricks.

1907 Cowan, R. G. Spitting out—a phenomenon of the decorating kiln. *Trans. Amer. Ceram. Soc.,* **9,** 493.

Accounts for this phenomenon as due to the presence of sulphur and reducing gases.

1907 Binns, C. F. Sulphur and sulphates. *Clay Worker,* **47,** 76.

A very carefully prepared article, written in simple terms, yet covering the cycle of sulphur in clay in its various forms most thoroughly. One of the masterpieces of the subject.

1907 Anon. Efflorescence in the muffle kiln. *Sprechsaal,* **40,** 423.

Question: Painted porcelain shows an efflorescence on the painting which does not appear when the bisque is burned very hard.

Answer: Ware too porous.

1907 Anon. Efflorescence in the muffle on flesh color. *Sprechsaal,* **40,** 633.

Question: How does one prevent efflorescence in the muffle, especially on flesh color?

Answer: Organic bodies are not entirely burnt out and carbon particles remain, especially if base is porous. This causes reduction. Fire longer.

1907 Anon. Efflorescence on glaze. *Sprechsaal,* **40,** 646.

Question: Porcelain glaze comes out of the bisque kiln all right (cone 13–14), but small black points come out in the muffle. Composition of glaze given.

Answer: There may be several causes. Looks like too much scrap in the glaze.

1907 Anon. Scum. *Brick and Pottery Trades Jour.,* **15,** 17.

Caused by SO_3 from coal on condensed water on ware. Heat to 300°F in clean air. Use $BaCO_3$ or coat with paste.

1907 Anon. *Brick and Pottery Trades Jour.,* **15,** 300.

Question: Is there any way to tell if a brick will effloresce?

Answer: Set it over a dish on wires and pour a gallon water through the brick. Evaporate the water. If the residue is great the brick will scum.

1907 Anon. Discolored bricks. *Brick and Pottery Trades Jour.,* **15,** 557.

Question: Buff bricks have developed brown spots or even fur on standing. Why?

Answer: You have run into a higher iron clay in your bank. Weather it.

1907 An Expert. Some defects and their causes. *Brick and Pottery Trades Jour.,* **15,** 16.

Review of subject.

1908 Zschokke, B. On the effect of various binding materials on the efflorescence of brickwork. *Tonind. Zeit.,* **32,** 380.

Takes exception to Mächler's work. Thinks soluble salts may well come from the mortar or be created or destroyed in firing. Tested eleven binders and found that after setting they were all full of soluble salts. Beside a new building he put a pile of the same bricks loose. After two years the walls were effloresced, the bricks were not.

1908 Anon. What is the remedy for whitewash on shale brick? *Clay Worker,* **49,** 809.

An appeal for help.

1908 Lacour, C. F. Answer to above. *Clay Worker*, **50**, 50.
Brick must be set dry in kiln.

1908 Drakebusch, W. Efflorescence on lime sandstones. *Tonind. Zeit.*, **32**, 614.
Refers to Mächler and has much the same problem, including the presence of vanadium.

1909 Lovejoy, Ellis. Discolorations on bricks. *Brick*, **30**, 97. (Translated in *La Ceramique*, **12**, 101.)
The whole history of scumming and efflorescence gone over, classified, and each class treated separately. Ends with a list of references. One of the masterpieces of the subject.

1909 Anon. Scum preventives. *British Clay Worker*. (Reprinted in *Brick*, **31**, 334.)
Barium chloride has been patented in Germany as a preventive, but has been tried and given up many times. Barium carbonate is satisfactory.

1909 Millar, J. C. How to ged rid of limestone scum from brick. *Brick*, **31**, 335.
An address.

1909 Anon. Cleaning of brick fronts. *Clay Record*, **34** [3], 31.
Sand blast not advised, nor steel wire brush. One part hydrochloric acid to twelve water best. It may be preceded by soap and water.

1909 Henschke and Niemer. Method to prevent the efflorescence of whiteware. German Pat. 208,478. (*Sprechsaal*, **42**, 437.)
Pour an excess of barium chloride solution over the ware and steam it.

1909 Anon. Scum. *Thonwaaren Fab.*, **35**, 105.
Ascribes scum to fire gases.

1909 Searle, A. B. Scummed or whitened bricks. *The Builders Journal*. (Reprinted in *Brick and Pottery Trades Jour.*, **17** [2], 66.)
In a certain English district all brick had a thin glazed scum. A new type of kiln was built there which produced unscummed bricks. Architects rejected these as underfired. It was found that the general opinion of architects was that bricks with glazed scum were harder.

1909 Anon. White bars on bricks. *Brick and Pottery Trades Jour.*, **17** [9], 421.
Question: How to avoid white stripes or bars on bricks as on samples sent.
Answer: Bars are drier scum caused by drying ware in kiln gases.

1909 Anon. White deposit on bricks. *Brick and Pottery Trades Jour.*, **17** [12], 566.
Question: Wants to prevent kiln scum. Barium carbonate too costly and only partially successful.
Answer: Reduction suggested just before finishing.

1910 Anon. Barium compounds to prevent scumming by sulphates. *Keram. Rund.*, **18**, 241.
Barium chloride as well as carbonate can be used. Chloride works fast but excess will form scum. Carbonate will not. Therefore take three quarters enough chloride to precipitate the sulphates and finish with an excess of carbonate.

1910 N. B. M. A. Convention. What is the best and cheapest method of eliminating whitewash from dry press brick? *Clay Worker*, **53**, 250.
Purdy advises $BaCO_3$. Cement often to blame.

1910 ANON. How to prevent discoloration of brick. *Brick*, **32**, 232.
Question and answer.

1910 ASHLEY, H. E. The technical control of the colloid matter in clays. *Trans. Amer. Ceram. Soc.*, **12**, 768.

Explains the reactions of barium carbonate with gels as well as with sulphates. This is why the "practical" test for the barium carbonate requirement of a clay is liable to lead to waste.

1910–1911 GREAVES-WALKER, A. F. Efflorescence on brick work. *Indus. and Eng. Chem.*, Sept. 1910. (Reprinted in *Brick and Clay Record*, **38**, 365 (1911).) *Brick Builder*, Jan. 1911, p. 86; *La Ceramique*, **14**, 173 (1911); *British Clayworker, Suppl.*, **19**, 86 (1911).)

Deals with the subject under the following heads: (*a*) composition of efflorescence, (*b*) causes, (*c*) methods of overcoming, (*d*) treating the clay, (*e*) treating the water, (*f*) correct drying. One of the leading articles on the subject.

1911 CAMPREDON, M. A new cause of scummed (effloresced) bricks. *British Clayworker*, **20**, 10. (Reprinted in *Clay Worker*, **55**, 745.)

He has found an efflorescence of practically pure sodium carbonate. Traced to the source of water for mortar and dipping bricks before laying.

1911 PERKIEWICZ, M. Protection to prevent the efflorescence of bricks. *La Ceramique*, **14**, 202.

Now uses resin as his base for a coating, or glue or other agglutinant mixed with one or several of a wide range of salts.

1911 HOFFMAN, H. O. AND MOSTOWITSCH, W. Reduction of calcium sulphate by carbon monoxide and carbon and oxidation of calcium sulphide. *Sprechsaal*, **44**, 235.

Reduction without loss of sulphur begins between 680° and 700°. Most rapid at 750° to 850°, complete at 900°. Decomposition in pure dry air begins at 1200°. Calcium sulphide heated in an oxidizing atmosphere becomes 73% sulphate, 27% oxide.

1911 ANON. Greasy scum on whiteware. *Sprechsaal*, **44**, 467.

Question: Special pieces like dish covers are poured instead of pressed. On these pieces we have a greasy scum.

Answer: The slip may be poured into the dried mold too rapidly and air trapped.

1911 ANON. Efflorescence on bricks. *Baumaterielmarkt*, No. **4** (1911). (Reprinted in *Tonind. Zeit.*, **35**, 208.)

Efflorescence appeared on a wall. It was traced back to a setter using ashes instead of sand to separate bricks in a ring furnace.

1911 ANON. Scum on firebricks. *Baumatèrielmarkt*, No. **24** (1911). (Abstract in *Tonind. Zeit.*, **35**, 928.)

Descriptive article.

1911 ANON. *Der Thonwaren Fabrikant.*, No. **14** (1911). *Tonind. Zeit.*, **35**, 1070.
Tells the story of efflorescence.

1911 ANON. *Baumaterielmarkt*, No. **48** (1911). (*Tonind. Zeit.*, **35**, 1789.)
Reviews the subject and gives precautions to take.

1911 ANON. Vanadium scum. *Tonind. Zeit.*, **35**, 1045.

Question: A yellow green scum comes out on a yellow whiteware soon after leaving the kiln.

Answer: Heat hotter and reduce. Heat above cone 010

1912 Binns, C. F. Discoloration on brick. *Brick and Clay Record,* **40,** 186, 415. (Reprinted in *Brick and Pottery Trades Jour.,* **20,** 227, 413.)

A thorough, concise explanation from a chemical point of view of the causes of scumming due to the clay, the water and the kiln gases. Advises the use of barium carbonate. Gives methods of testing water and clay that can be used at any brick plant.

1912 Voigt, A. More light on efflorescence. *Brick and Clay Rec.,* **40,** 187.

Discusses recent communications.

1912 Anon. Sensible solution of world wide problem. *Brick and Clay Rec.,* **40,** 47.

Discusses scumming and efflorescence. Writer gets rid of it by raising the heat slowly.

1912 Anon. The prevention of scum. *Brick and Clay Rec.,* **40,** 59.

Advocates use of precipitated barium carbonate.

1912 Anon. Scum on best bricks. *Brick and Pottery Trades Jour.,* **20,** 111.

Question: Has scum and wants to avoid it.

Answer: Due either to salt in clay or to incomplete drying.

1912 Anon. Scummed burnovers. *Brick and Pottery Trades Jour.,* **20,** 563.

Question: Underfired bricks reset are generally spoiled with scum. Can this be prevented?

Answer: Dip in gruel before resetting or wrap in brown paper.

1912 Anon. Salty deposits on brick work. *Revue Scientifique.* (Reprinted in *Canadian Clay Worker,* Sept., 1912, p. 21.)

Review.

1912 Perkiewicz, M. How to combat scum and efflorescence. *Tonind. Zeit.,* **36,** 577.

Advises coating with bakelite.

1912 Seger and Cramer. Efflorescence on brickwork. *Tonind. Zeit.,* **36,** 1149.

Describes experiments on soaking ware in solutions of various salts and mixtures and then testing for efflorescence. Conclusions point to hydrochloric (muriatic) acid as a good cleaner for efflorescence.

1912 Anon. To prevent efflorescence. *Ziegel und Bau-Industrie.* (Reprinted in *Tonind. Zeit.,* **36,** 1404.)

Advises barium carbonate to precipitate sulphates and ammonium oxalate for excess lime.

1912 Anon. Efflorescence on sand lime bricks. *Tonind. Zeit.,* **36,** 1907.

Bricks were stacked on ashes and absorbed soluble salts which later effloresced.

1913 Binns, C. F. Efflorescence and how to stop it. *Brick and Clay Rec.,* **43,** 1017.

Goes carefully and thoroughly all over the subject. Does not advise barium chloride but recommends carbonate. Gives very simple method of testing clays to find how much barium carbonate to use.

1913 Anon. Cures clayworkers' worst trouble. *Brick and Clay Rec.,* **43,** 156.

Advises use of precipitated barium carbonate.

1913 Anon. Wants to prevent scummed brick. *Brick and Clay Rec.,* **43,** 805.

Question: Having scum trouble.

Answer: Read the literature. List given.

1913 Grace, P. Corrects information on scumming. *Brick and Clay Rec.*, **43**, 909.
Corrects recent discussion. Advises the reading of Lovejoy's pamphlet.

1913 Anon. Efflorescence—here it is again. *Brick and Clay Rec.*, **43**, 1037.
Question: Having trouble with efflorescence.
Answer: Read the literature.

1913 Pommer, O. More cures for efflorescence. *Brick and Clay Rec.*, **43**, 1150.
Had bricks scum that had stood two weeks in the drier. Another plant found that Cramer's remedy of reduction was good but turned red bricks brown.

1913 Anon. Scumming. *Brick and Clay Record*, **43**, 909.
An abstract from Lovejoy's "Scumming and Efflorescence."

1913 Hoshour, C. Prevention of whitewash. *Clayworker*, **59**, 402. (Reprinted in *Canadian Clay Worker*, April, 1923, p. 34.)
A long address to the N. B. M. A. Convention. Advises $BaCO_3$.

1913 Anon. Efflorescing salts on brick. *Tonind. Zeit.*, **37**, 1958.
In a case of dispute there were found in some instances 0.4% to 0.5% soluble salts, in others 0.001% to 0.003%. The difference was found in the firing. The bricks low in soluble salts were yellow and hard fired; the others were dark and underfired. The cause of efflorescence is held to be sulphur in coal. Thorough firing is urged as a means of preventing efflorescence.

1913 Anon. Yellow efflorescence on stove tile. *Keramische Rundschau*, **21**, 201.
Due to soluble salts, especially sulphates, which may have entered in any of several ways.

1913 Anon. Efflorescence on porcelain glaze. *Keram. Rund.*, **21**, [illegible]69
May be due to impurities in glaze as gypsum. Try changing materials and coal.

1913 Anon. Produces scum on drying ware. *Brick and Clay Rec.*, **43**, 1152.
Waste flue gases may be used for drying but should first be diluted.

1913 Anon. Efflorescence due to cement coloring. *Tonind. Zeit.*, **37**, 573.
Colorants sometimes contain water soluble salts which cause efflorescence.

1913 A. R. Efflorescing salts. *Tonind. Zeit.*, **37**, 1985.
Describes experiments with mixtures.

1914 Anon. Scum-free water hardening mortar. *Tonind. Zeit.*, **38**, 1507.
A German patent. Contains barium fluoride.

1914 Anon. Efflorescence on red tile. *Keram. Rund.*, **22**, 92.
The trouble is due to soluble sulphates which have entered the ware in some way. Test your sand and grog.

1914 Anon. Efflorescence on stove tile. *Keram. Rund.*, **22**, 235.
Answer: The efflorescence is due to soluble salts which, in a kiln of your kind, can be traced only to the lining.

1914 Anon. Efflorescence and stains on terra cotta. *La Ceramique*, **17**, 186.
A long general review.

1914 Anon. More scum trouble. *Brick and Clay Rec.*, **44**, 90.
Our brick scum on one side and two ends, not on side against rollers of table.
Answer: More probably drier trouble. Mark brick and read Prof. Binns' article. *Brick and Clay Rec.*, **43**, 1017 (1913).

1914 ANON. Has scum trouble. *Brick and Clay Rec.*, **44,** 363.

Brick are a clear clean color before being wet, then effloresce very badly. Have read Prof. Binns' article. Where can I get barium chloride?

Answer: Advises weathering clay, washing if lime is in pebbles, getting an analysis of clay and asking an expert.

1914 BOSS, J. C. Reply to C. F. Binns' article. *Brick and Clay Rec.*, **44,** 263.

Whitewash or efflorescence is brought about in three ways. First, if the moisture is brought to the boiling point before it can escape from the drier. Second, if clean dry bricks are set in a kiln and the moisture comes to a boiling point before it is expelled from the kiln, whitewash is reëstablished. Third, if not properly vitrified, they will immediately effloresce when wet.

1914 BINNS, C. F. Reply to J. C. Boss. *Brick and Clay Rec.*, **44,** 370.

Binns' article was on scumming and had nothing to do with efflorescence. Brick are never at first put into an atmosphere in the drier as hot as boiling water. It is never entirely true that efflorescence is a deposit. Will answer definite questions.

1914 KINNISON, C. S. Ashes and scumming. *Brick and Clay Rec.*, **44,** 588.

Many a case of scumming is due to ashes. Also bricks should never be stacked in ashes.

1914 BUTLER, W. A. Scum—what is it? *Brick and Clay Rec.*, **44,** 592.

Scum is condensed water smoke. Subject explained from this viewpoint.

1914 BINNS, C. F. Scum once more. *Brick and Clay Rec.*, **44,** 1049.

States the facts in regard to scum even more simply and clearly than has already been done.

1914 KNAPP, E. W. Whitewash. *Brick and Clay Rec.*, **44,** 1050.

Gives rule-of-thumb tests to locate trouble and get rid of it.

1914 ANON. *Brick and Clay Rec.*, **44,** 1150.

Advises use of $BaCO_3$.

1914 ANON. Seems to have the old scum trouble. *Brick and Clay Rec.*, **45,** 52.

Question and answer on drier scum.

1914 BENTLEY, M. D. Scum. *Brick and Clay Record*, **45,** 58.

"We know everything about scum except how to be rid of it." Gives good advice on kiln firing.

1915 STALEY, H. F. The use of barium fluoride for the prevention of drier scum on bricks. *Trans. Amer. Ceram. Soc.*, **17,** 200.

Advantages of fluoride over carbonate are:

1. It is less expensive.
2. It is more soluble than $BaCO_3$.
3. The amounts required are the same or less.
4. It has no deleterious effect on the color of the fired ware.
5. An excess does not produce a scum.
6. It promotes vitrification.

(EDITOR'S NOTE: Barium fluoride is now very scarce in commercial quantities. It sells at 18 c. a pound, compared to 5 c. a pound for barium carbonate.)

1915 STALEY, H. F. The effect of salts on the drying behavior of some clays. *Trans. Amer. Ceram. Soc.*, **17,** 697.

While both common salt and soda ash increased the amount of scum found on drying, they caused no scum on fired ware. In one case increasing amounts of these salts

progressively decreased a scum already present. They evidently volatilized or fluxed the scum.

1915 Williams, A. E. Experiments to overcome scumming and improve the color of bricks. *Trans. Amer. Ceram. Soc.*, **17**, 764.

Tried spraying solutions of ferrous sulphate and ferric chloride on wet and dry green brick. On dry brick there was no effect ever. On wet brick, scumming was diminished or prevented and the ware flashed better. Ferric chloride served better than ferrous sulphate.

1915 Emley, W. E. and Young, S. E. The production, manufacture and use of compounds of barium. *Trans. Amer. Ceram. Soc.*, **17**, 240.

Describes occurrence and manufacture of compounds. Use of chloride and carbonate to prevent efflorescence. Describes "practical" plant control method with chloride. Recommends adding nearly enough chloride, balance carbonate.

1915 Garve, T. W. Notes on German clay working plants. *Trans. Amer. Ceram. Soc.*, **17**, 592.

Describes a plant firing a limey clay with sulphurous brown coal in a ring furnace without advance heating flues. Clay is very fine ground to avoid popping. Reduction is applied for from twenty minutes to two hours to decompose the calcium sulphate on the surface. The characteristic buff lime-iron silicate is formed.

In another plant making roofing tile the clay bar from the augur machine is coated with glue to prevent scumming.

1915 Williams, A. E. How to prevent efflorescence in finished brickwork. *Brick and Clay Rec.*, **47**, 341.

A thoroughgoing treatise on this subject. Emphasizes the importance of removing the fires and ashes at the end of firing. Mortar should be treated with barium carbonate.

1915 Anon. Removing and preventing efflorescence. *Brick and Clay Rec.*, **47**, 420.

Question about mortar freezing and efflorescence trouble. Answer gives a soap and alum wash to waterproof the wall.

1915 Anon. Removing efflorescence from finished brickwork. *Brick and Clay Rec.*, **47**, 441.

Review of the subject.

1915 Anon. Making clean brickwork. *Brick and Clay Rec.*, **47**, 506.

Wall efflorescence often due to mortar. Describes methods of cleaning and waterproofing.

1915 Anon. Cleaning scummed brickwork. *Brick and Clay Rec.*, **47**, 659.

Williams recommends washing with 10% hydrochloric acid, or 1% soap and then acid.

1915 Anon. Efflorescence on Majolica enamel. *Keram. Runds.*, **23**, 254, 261.

Question: We have occasionally found that our near-majolica ware has an efflorescence after standing a while.

Answer: The enamel is not properly mixed.

1916 Williams, A. E. Dissociation of calcium sulphate and the removal of drier scum. *Trans. Amer. Ceram. Soc.*, **18**, 271.

Laboratory experiments on reducing gypsum and clay mixtures show that reduction is rapid at 800°C.

Tests for substitutes for barium carbonate showed that barium fluoride and hydroxide and sodium oxalate and fluoride were equally good.

1916 Anon. The effect of mine water on finished ware. *Brick and Clay Rec.*, **48,** 248.
Question: Will water pumped from a coal mine cause scum if used to pug clay?
Answer: It probably will.

1916 Anon. Used wrong acid on brickwork. *Brick and Clay Record,* **48,** 448.
Question: I washed a church with acid to remove scum. I was sold sulphuric instead of muriatic. On drying a white coating developed. Is there any hope?
Answer: Only years of weathering.

1916 Anon. Will weathering clay minimize scumming? *Brick and Clay Rec.*, **48,** 645.
Question: Would weathering help a marl that scums though water-smoked with wood?
Answer: Probably, but it would take a long time.

1916 Anon. Salt glazed brick "whitewash" after exposure. *Brick and Clay Record,* **48,** 1042.
Question: Have tried salt glazing bricks which sometimes scum a bit. They turned white 24 hours after leaving the kiln. Can this be prevented?
Answer: Use less salt and higher temperature. Salt is not much good below cone 4.

1917 Binns, C. F. Efflorescence and how to stop it. *Brick and Clay Rec.*, **50,** 659.
Goes very carefully all over the subject again, clearing up points apparently misunderstood in his article in 1913. (*Brick and Clay Rec.*, **43,** 1017.)

1917 Anon. Is your scum due to these causes? *Brick and Clay Rec.*, **51,** 413.
Methods of avoiding water condensation on ware.

1917 Pallus, H. and Jakob, K. Efflorescences. *Tonind. Zeit.*, **41,** 155, 283, 401.
A brief discussion of these occurrences in bricks. P. states that the best way of destroying the salts is a sharp fire. J. contributes a critical review. P. replies.

1918 Anon. Using barium carbonate to prevent scum. *Brick and Clay Record,* **53,** 54.
Coral Ridge Clay Products Co. adds 28 lbs. of barium carbonate dry per M bricks at the dry pan. Gets better and darker reds.

1918 Anon. *Brick and Clay Rec.*, **53,** 1161.
Question: Want something to add to brick to prevent efflorescence.
Answer: See preceding article.

1920 Gates, M. E. A satisfactory method of using barium hydrate in terra cotta bodies. *Jour. Amer. Ceram. Soc.*, **3,** 313.
Need not use a double portion as with carbonate, therefore cheaper. Shows device to get the barium into solution warm and feed it at a constant rate.

1920 Anon. "Scumming bothers this concern." *Brick and Clay Rec.*, **57,** 64.
Question: Wants to know if waste heat from kilns can be used for water-smoking and not cause scum.
Answer: It is often done and may or may not cause trouble. Fire boxes should be cleaned first.

1920 Lovejoy, Ellis. Burning clay wares. Published by T. A. Randall & Co., Indianapolis, Ind. 2nd edition, 1922.
On pages 328 to 332 describes the usual forms of scum and some unusual cases that have come to his attention.

1920 Anon. Scum on brick. *Clay Worker,* **73,** 37.
Question: Has scum trouble and sends two sample bricks.

Answer: One was scummed by sulphur in the die oil, the other apparently by sulphur in the coal.

1921 Anon. Scumming of whiteware and peeling off of glazes. *Sprechsaal*, **54**, 429.
In whiteware there is often a tendency for glaze to peel off especially along the edges due to soluble sulphates. This scum prevents glaze from sticking to body. Barium chloride or carbonate will prevent the scum.

1921 Anon. The use of barium fluoride to prevent scumming. *Sprechsaal*, **54**, 547–8. (*Ceram. Abstracts*, **1** [8], 212.)
Refers to Lovejoy's and Staley's articles and gives their same arguments.

1921 Anon. Eliminating white scum from face brick. *Brick and Clay Rec.*, **59**, 365. Question and answer.

1922 Parmelee, C. W. Soluble salts and clay wares. *Jour. Amer. Ceram. Soc.*, **5** [8], 538. (Reprinted in *Brick and Clay Rec.*, **61**, 249, 316.)
Definitions of efflorescence and scum. Description of their occurrence, formation and prevention. Describes a white scum often found in a kiln on opening and which readily disappears. It was chiefly sodium sulphate and chloride. He suggests that it came from the fires and ash after the ware had cooled too low to form a glaze.

1922 Hirsch, H. Scum on bricks. *Tonind. Zeit.*, **46**, 521.
Discolorations on bricks described and sources traced. Manganese mentioned as an occasional source.

1922 Hill, C. W. Notes of green staining of clay ware. *Bull. Amer. Ceram. Soc.*, **1** [2], 51. (With *Journal* of June, 1922.)
Yellow green staining on ceramic products exposed to weather has usually been ascribed to vanadium. Seger's view has been perpetuated in the literature. Hill found green on ware from clay containing pyrites. Digestion of a sample of stain with acids gave no iron test. Fusion with alkali and solution in acid developed a heavy iron test. Iron apparently combined with alumina or silica. This test has since been repeated with a positive result for iron whenever examples of green staining could be found. The stain is dissolved by oxalic acid or alum and sulphuric acid.
Seger's clays seem to have been different, but Hill is inclined to believe that with Eastern and Central clays the stain is probably due entirely to iron.

1922 Anon. Scum on Belgian bricks. *Tonind. Zeit.*, **46**, 632.
Analysis showed 92–7% magnesium sulphate.

1922 Anon. Cause of black efflorescence. *Sprechsaal*, **55**, 309.
Question: What is the cause of black efflorescence at decorations?
Answer: Reduction.

1922 Kallauner, O. and Hruda, I. The occurrence of vanadium in ceramic raw materials and ware and its effect upon the fusibility as well as the color and formation of scum on a pure kaolin and a brick clay. *Sprechsaal*, **45**, 333–5, 345–9. (*Ceram. Abstracts*, **2** [3], 57.)
Quantitative results on mixtures fired at different temperatures both oxidizing and reducing with various preventive salts added. Barium and calcium carbonates are good.

1922 Anon. Use of barytes in overcoming scum. *Brick and Clay Rec.*, **60**, 49.
Question: Wants to know how to use barytes in stiff mud plant to overcome scum.
Answer: It may be added at the dry pan. It is better to add only milk of barytes at the pug.

1922 ANON. Use of barytes in controlling scum. *Brick and Clay Rec.*, **60**, 298.
The above repeated.

1922 ANON. Difficulties in scumming. *Brick and Clay Rec.*, **60**, 386.
Question: Have trouble with scumming even with barium carbonate and require 200 hours to burn ware.
Answer: Better have a consultant.

1922 ANON. Scumming efflorescence and whitewash. *Brick and Clay Record*, **60**, 602.
A long thorough description with illustrations and several references. Gives 13 causes and 14 methods of prevention.

1922 ANON. Troubled with intermittent whitewash. *Brick and Clay Rec.*, **60**, 859.
Question and answer.

1922 ANON. Troubled with whitewash. *Brick and Clay Rec.*, **60**, 935.
Question and answer.

1923 BLEININGER, A. V. The effect of acids, alkalis and salts on clay bodies. *Ceramist*, **3** [1], 48.
Discusses soluble salts and their determination. Their accumulation on the surface and particularly the edges of whiteware results in a skin which will not take a glaze. Remedy, barium carbonate. Mention effects on heavy clay wares.

1923 ANON. Scumming on roofing tile. *Tonind. Zeit.*, **47**, 272.
Soluble salts cause scumming which has been prevented with barium carbonate. This is becoming too expensive. The amount has sometimes been reduced by adding fine sand to clay, thus reducing the percentage of soluble salts.

1923 ANON. White scum on brickwork. *Deut. Töp. Zieg. Ztg.*, **54**, 144.
This is not always due to the raw materials. Instances are cited (*a*) stored in unsuitable places at building site, (*b*) impure water or unsuitable materials for mortar, (*c*) insufficient protection from external influences.

1923 BIGOT, F. Stain and efflorescence on ceramic products. *Rev. Mat. Constr. Trav. Pub.*, **166**, 122–213. (*Ceram. Abstracts*, **2** [12], 288.)
Green stain or efflorescence has been noticed on clays heavily charged with mica. A kieselguhr containing manganese did the same on exposure. A stoneware clay with a 2–3% chromite fired to 1200° oxidizing developed green scum. Calcareous white bodies for faience with heavy lead glaze often show the yellow characteristic of lead and chromium. This is not observed in tin opaque glazes. The green is found on clays containing alkalis, large quantities of alkaline earths not preventing its formation.

1923 LOVEJOY, ELLIS. Coloration, discoloration and other burning effects. *Clay Worker*, **79**, 38. (*Ceram. Abstracts*, **2** [5], 96 P.
A long and thorough exposition of the subject.

1923 ANON. Getting rid of scum. *Brick and Clay Rec.*, **63**, 348.
Question: Nature of green stain on light buff face brick.
Answer: Has been ascribed by Seger to vanadium salts or algae. Hill ascribes to iron. See *Jour. Amer. Ceram. Soc.*, June, 1922, p. 51.

1924 JACKSON, F. G. The behavior of calcium compounds in clays. *Jour. Amer. Ceram. Soc.*, **7** [6], 427.
Previous theories on the formation and decomposition of calcium sulphate as kiln scum are confirmed. Quantitative analyses on the effect of definite heat treatments put the subject on a more definite basis.

1924 STRAUMFORD, J. F. How we eliminated scum on sewer pipe. *Brick and Clay Rec.*, **65**, 385.

Scum formed on sewer pipe during glazing due to oil as fuel. Found scum caused by reducing conditions.

1924 ANON. Eliminating scum. *Brick and Clay Rec.*, **65**, 404.

Question: Have just had an entire kiln scum. Have had very little before. We fire with natural gas, water-smoke six days with doors wide open. Clay came from a newly stripped part of bank.

Answer: Sounds like sulphate scum caused by a partially soluble salt. Try barium carbonate.

ACTIVITIES OF THE SOCIETY

NEW MEMBERS RECEIVED FROM JUNE 15 TO JULY 15

PERSONAL

Jean Boyau, % International General Electric Co., Schenectady, N. Y.

John Burgess, Jr., % Gordon Kaolin Co., Gordon, Ga. Superintendent.

A. DeGallaix, 359—1st St., Niagara Falls, N. Y. Ceramic Engineer, Carborundum Company.

Clyde Denlinger, 205 Norwood Ave., Buffalo, N. Y. Superintendent, Steel Division, Bethlehem Steel Co., Lackawanna, N. Y.

C. Arnold Dutton, 1262 Ontario St., Cleveland, Ohio. District Sales Representative, Carborundum Company.

W. H. Funk, Harbison-Walker Refractories Co., Pittsburgh, Pa.

Samuel V. Jolliffe, Box 1672, R. R. No. 2, Glendale, Calif. Superintendent, Terra Cotta Department, Los Angeles Pressed Brick Co.

Donald K. Macleod, % Gladding, McBean & Co., Glendale, Calif. Superintendent, Tile Department.

Herbert P. Margerum, % Golding Sons' Company, Trenton, N. J. President.

A. G. Mason, Lisbon, Ohio. Manager, Lisbon Factory of the R. Thomas & Sons Co.

Fred W. Miller, 812 Kenmore Road, Overbrook, Philadelphia, Pa. The Carborundum Company, Perth Amboy, N. J.

Cullen E. Parmelee, Crystal, Mo. Pittsburgh Plate Glass Co.

John A. Paulsen, % Thos. Moulding Brick Co., 133 W. Washington St., Chicago, Ill. Refractories Sales Manager.

J. A. Rumer, 54 N. Parkside Ave., Apt. 1, Chicago, Ill. Chicago Representative of The Ferro Enamel Supply Co.

R. L. Shugg, General Motors Bldg., Detroit, Mich. Assistant District Manager, American Rolling Mill Co.

William H. Vaughan, Georgia School of Technology, Atlanta, Ga.

CORPORATION

Hydraulic-Press Brick Co., 705 Olive St., St. Louis, Mo. George F. Baker, Secretary and Treasurer.

Membership Workers' Record

	Personal	Corporation
Charles F. Geiger	4	
Roy A. Horning		1
C. R. Minton	1	
Cullen W. Parmelee	1	
P. H. Walker	1	
R. A. Weaver	1	
Office	8	
	16	1

PRESENT ADDRESSES UNKNOWN

NOTE: Kindly notify the Secretary of the SOCIETY if you know the correct address of any of the members listed herewith.

All-In-One Plumbing Fixture Corp., 231 Ochsner Bldg., Sacramento, Calif.
William Birner, Box 139, R. R. No. 1, East San Gabriel, Calif.
G. V. Baker, Pennsylvania Feldspar Co., Barnard, N. Y.
Leo T. Butman, F. R. Muller & Co., Waukegan, Ill.
J. P. Callaghan, ℅ Teaque Hotel, Montgomery, Ala.
Edna P. Carson, Schenley High School, Pittsburgh, Pa.
T. M. Caven, 564 W. 173rd St., New York City.
Frank J. Connors, Y. M. C. A., Room 14, Winsted, Conn.
August F. Danes, Laclede-Christy Clay Products Co., St. Louis, Mo.
Charles S. Dolley, Keramoid Mfg. Co., Fort Madison, Iowa.
S. P. Edson, Bryantville, Mass.
P. P. Francais, 1329—7th St., Lorain, Ohio.
M. S. Gifford, Lake Bluff, Ill.
A. H. Goodman, Box 915, Pittsburgh, Pa.
John L. Greenwood, Lehigh Sewer Pipe & Tile Co., Lehigh, Iowa.
C. Knox Harding, 6318 Stony Island Ave., Chicago, Ill.
Kenneth E. Holley, Alfred, N. Y.
Isaac Kahn, 2428 Reading Road, Cincinnati, Ohio.
G. S. Kennelley, 3265 Philadelphia W., Detroit, Mich.
J. M. Knote, J. H. Gautier & Co., Green & Essex Sts., Jersey City, N. J.
Roy Lacy, 634 S. St. Andrews Place, Los Angeles, Calif.
Arthur T. Leahy, 5490 Ellis Ave., Chicago, Ill.
William W. Lemmax, Box 59, Taylor, Wash.
George W. Lester, 2176 McClellan Ave., Detroit, Mich.
F. G. Lord, Pennsylvania Pulverizing Co., 341—4th Ave., Pittsburgh, Pa.
A. T. Meldram, Strathcona Potteries, 99 St. James St., Montreal, Can.
C. F. Miller, University of Washington, Seattle, Wash.
F. H. Nies, Hamilton Ave. & Summit St., Brooklyn, N. Y.
F. W. Owens, 3507 E. Baltimore St., Baltimore, Md.
Walter A. Preische, Alfred, N. Y.
H. M. Pulsifer, Manhattan Bldg., Chicago, Ill.
Gordon W. Reed, 407 S. Dearborn St., Chicago, Ill.
A. E. Saunders, 48 Albemarle Ave., Toronto, Ont., Can.
A. Lincoln Scott, Auditorium Tower, Chicago, Ill.
Lee Showers, Pittsburgh Plate Glass Co., Pittsburgh, Pa.
Olin F. Shults, Alfred, N. Y.
George Sirovy, 1486 Perry St., Des Plaines, Ill.
Clarence A. Stimpson, Chicago Pneumatic Tool Co., Century Bldg., Chicago, Ill.
Charles H. Stone, Jr., 1210 Oak St., Jacksonville, Fla.
Evelyn Tennyson, Alfred, N. Y.
Erwin F. Theobald, General Delivery, Bessemer, Pa.
Boris Trifonoff, 631 Putnam Ave., Zanesville, Ohio.
Mrs. David Vanderkooi, 733 Michigan Ave., Portland, Ore.
Bernard Vane, Hopewell, Va.
John H. Voorhies, Alfred, N. Y.
Frank A. Weidman, 38 S. Dearborn St., Chicago, Ill.
G. N. White, 7 Victoria Ave., Worcester, England.
Heinrich Willmer, Cologne Nippes, Germany.

PERSONAL NOTES

Robert J. Anderson, Metallurgical Engineer, has moved his consulting office from Boston, Mass., to Pittsburgh, Pa., and is living at 221 Amber St., E. E., Pittsburgh.

F. S. Crumley, President of the Indiana Sanitary Pottery Co., has moved from Chicago to 407 Johnson St., Hammond, Ind.

Albert C. Gerber, who has been employed as Ceramic Engineer for the J. L. Mott Co., of Trenton, N. J., has recently taken a similar position with the General Ceramics Co., of Metuchen, N. J.

Robert E. Gould, who received his degree in Ceramic Engineering in June, 1925 at Ohio State University, is employed by the R. Thomas & Sons Co., Lisbon, Ohio.

Richard D. Hatton, formerly Vice-President and General Manager of the Laclede-Christy Clay Products Co., now holds a similar office with the Los Angeles Pressed Brick Co., Los Angeles, Calif.

F. A. Kirkpatrick has moved from Burlingame, Calif., to Unionville, Mich.

A. R. Mallon has moved from McKees Rocks, Pa., to 1216 Greenfield Ave., Canton, Ohio.

Joseph K. Moore of New York City writes that his present address is 701 N. Michigan Ave., Chicago, Ill.

Howard W. Pigott has moved from Philadelphia, Pa., to 416 Addison Road, Riverside, Ill.

F. W. Runge, formerly connected with The Ferro Enameling Co., Cleveland, Ohio, has accepted a position with the Andes Range & Furnace Corp., of Geneva, N. Y.

Leonard Sheerar has taken a position with the Dover Fire Brick Co., Dover, Ohio. Mr. Sheerar received his degree of Master of Science in Ceramic Engineering at Ohio State University, June 1925.

George R. Snyder, Metallurgist for Harbison-Walker Refractories Co., has been transferred from the Pittsburgh office to the Buffalo office of that Company.

CALIFORNIA LOCAL SECTION

A meeting of the California Local Section was held in Los Angeles, June 29. There were forty-seven in attendance. The dinner was followed by a very interesting program which consisted of:

"The Machinery Arrangement for the Clay and Grog Preparation in the Manufacture of Glass Pots and Tank Blocks," by T. W. Garve.

"Flint Glass for Prescription Bottles," by W. H. Test.

"Window Glass Manufacture in Southern California," by LeRoy Dixon.

"Some Orange County Clays," by Ray Boggs.

W. H. Sheppard of the Los Angeles Chamber of Commerce gave an inspiring talk on ceramic education in California. A resolution was adopted to further the movement to establish a ceramic course at the University of California, Southern branch. F. B. Ortman was appointed to head the committee to coöperate with the Chamber of Commerce and the State Education authorities.

HEAVY CLAY PRODUCTS DIVISION

Your Committee on Research would be interested to know what researches the members of the Division are contemplating or carrying on at present. We would also be glad to receive suggestions. If you have any question that is troubling you and that can be settled by investigation, let us know about it.

If you pick up any facts of general interest, send them in. Here is an example that your chairman recently found at a sewer pipe plant. The kiln was 32 feet diameter and the charge weighed 43.5 tons. Each shovelful of coal weighed 11.1 pounds. There were 9 fireboxes. Therefore, when the fireman went around and put, for example, three shovelfuls on each fire, he had put on 300 pounds of coal. During the first 50 hours of firing, every 100 pounds of coal raised the kiln temperature 10°F. Eight hundred degrees F was attained with 8000 pounds of coal. Before 900°F was reached the fires had been cleaned and a total of 13,000 pounds of coal had been used. One hundred degrees F was rapidly gained after this and the ratio still held up to 1400°F. One thousand one hundred degrees F cost 14,000 pounds, 1200° cost 15,000 pounds, 1300° cost 16,000 pounds, and 1400° cost 17,000 pounds. After that the coal consumption increased more rapidly than the temperature. Temperatures were taken seven feet in through the wicket. Of course a charge of 12-inch sewer pipe does not weigh much compared with brick, and therefore heats with less coal. Can anyone else send in some figures like this?

F. G. JACKSON, Chairman, Comm. on Research.

SUMMER MEETING IN CANADA

Forty-six members of the AMERICAN CERAMIC SOCIETY attended the recent Summer Meeting of the SOCIETY held in Canada July 4–11. A total registration of 165 was made. The papers presented at the technical session held in Toronto on July 9 are presented in this issue of the *Bulletin*.

NOTES AND NEWS

G. A. BOLE MADE SUPERVISING CERAMIST OF U. S. BUREAU OF MINES

G. A. Bole is designated as Supervising Ceramist of the Bureau of Mines and as such will have technical supervision of all ceramic investigations carried on by the Bureau, both at the Columbus Station and at the other experiment or field stations, acting through the respective station superintendents in the usual manner. Mr. Bole will also continue in his position as Superintendent of the Columbus Station.—

D. A. LYON, Acting Director, Dept. of Commerce, Bureau of Mines.

GLASS TECHNOLOGY IN THE UNIVERSITY OF PITTSBURGH

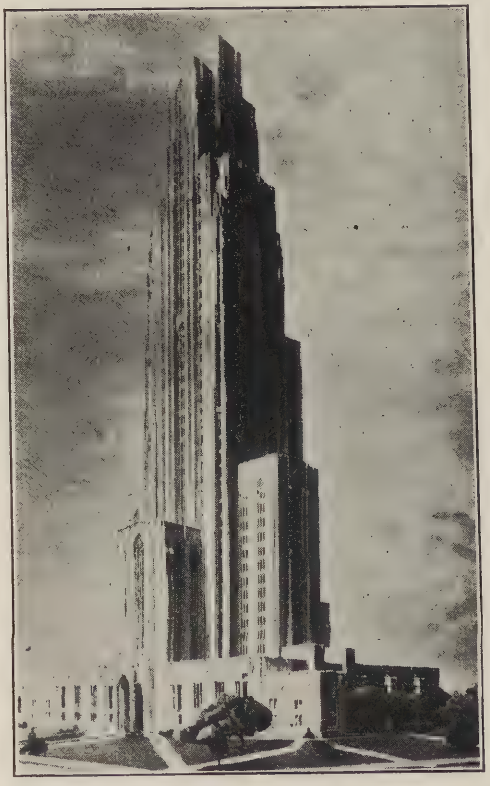
BY ALEXANDER SILVERMAN

When the writer was called into a glass factory as chemist in 1902, just after graduating from college, there was little in America that might be honored with the title "Glass Technology." Chemists in the industry could be counted on the fingers of one hand. Today we find more chemists in the laboratories of a single manufacturer than the entire industry employed only twenty years ago.

In the University of Pittsburgh the study of glass has been confined to a lecture course on the subject; to graduate research by candidates for masters' and doctors' degrees; to investigations, in the field of pure research, or in a consulting capacity, by professors; and to the industrial researches under the fellowship system in the Mellon Institute of Industrial Research. The lecture course in glass technology has rarely

been available for any but graduate students because of the importance of physical chemistry, which students pursue during their senior year.

While it is not likely that students will be able to enter properly upon the study of the science of glass making until they have had training in inorganic, analytical, and physical chemistry, and in the fields of physics and mathematics, one might perhaps have the freshman make silicate and borate melts during the study of silicon and boron and later, when he studies the alkali and alkaline-earth metals, let him prepare a few simple glasses. Analytical chemistry might include the examination of raw materials and glasses, physical laboratory practice can cover the making of physical measurements on glass, and physical chemistry might include a study of eutectics and equilibria as well as the influence of temperature on chemical reactions and physical properties. Whether a four-year undergraduate course will be established to train glass technologists is still uncertain, but that a beginning will be made in training men for this important industrial field is assured.



Men on the faculty of the University, and in the Mellon Institute, have made such progress in glass investigation during the past score of years that attention is focused on the University, with the expectancy of further development. Pittsburgh is one of the most important glass centers in the world, if not the most important. The industry began in this district in 1797. Pittsburgh today manufactures more than one-half of the window glass of the United States and one-third of the plate glass and pressed and blown ware of the country. Its bottle plants turn out one-eighth of all glass containers used.

The University of Pittsburgh is glad to announce a gift of fifty thousand dollars for the establishment of the first "Laboratory of Glass Technology" in an American institution of higher learning. This will be a part of the Chemistry Department and will be located in the new "Cathedral of Learning," the fifty-two story building on which the University plans to begin building operations in the Fall, completing the structure in approximately three years. The contribution comes from Isaac W. Frank, in memory of his father, William Frank, who was one of Pittsburgh's pioneers in the glass field. It is expected that an additional amount will follow the original gift.

With this prospect, the University of Pittsburgh hopes to fill the long-felt need for the training of technical men for the glass industry.

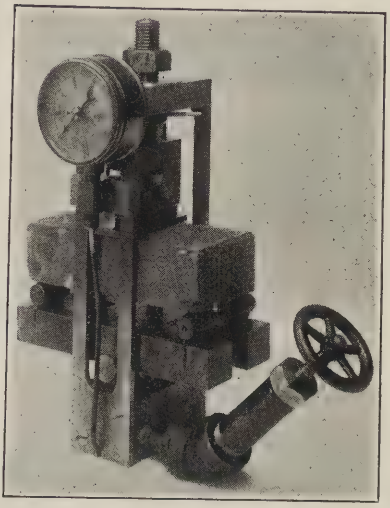
Department of Chemistry
University of Pittsburgh

BUREAU OF STANDARDS NOTES

Portable Brick Tester

1. This machine was designed for an oil pressure of 2000 pounds per square inch or a total compressive load of 4000 pounds. It consists essentially of the equalizer apparatus for transverse tests of brick described in Bureau of Standards Technologic Paper, No. 251 and a hydraulic jack which applies the load. It is comparatively light in weight (about 35 pounds), simple in operation and accurate in determining the breaking load.

2. By its use, it is hoped that delays incident to sending samples of brick to a testing laboratory can largely be avoided and that the inspector on the job can determine whether the brick have the required strength. This will tend to eliminate controversy between the contractor and inspector, and also between the manufacturer and the contractor.

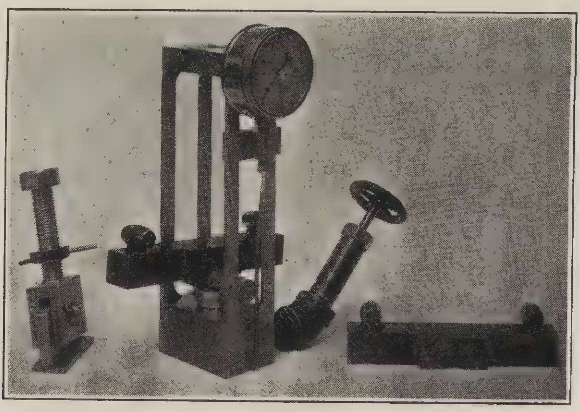


3. These machines are made by the Morehouse Machine Company, 233 West Market Street, York, Pa.

Technical News Bulletin, No. 98, gives the following description of the tester:

"A portable machine for testing brick in cross bend has been designed by A. H. Stang, of the engineering mechanics section of the Bureau, and construction is practically completed. The machine will weigh about 40 pounds, is hydraulically operated, 16 inches high, 6 inches wide and 12 inches long.

"On account of the proposed change in the A.S.T.M. specifications, for brick testing, which will probably eliminate all physical tests except the cross-bend test,

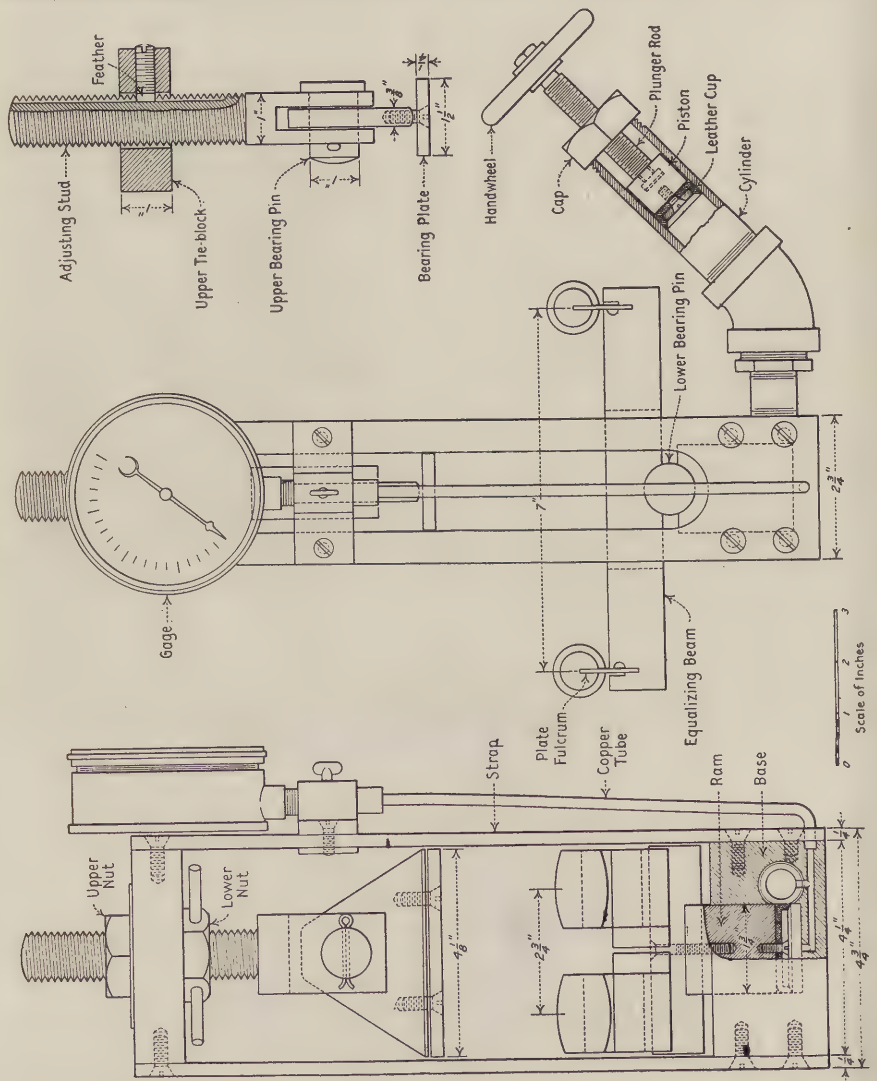


the need for such a machine is evident. With this machine an inspector can test brick on the job and will not need to send specimens to a distant testing laboratory. Delays can thus be avoided and a real indication given of the quality of the brick."

Architectural Terra Cotta Investigations

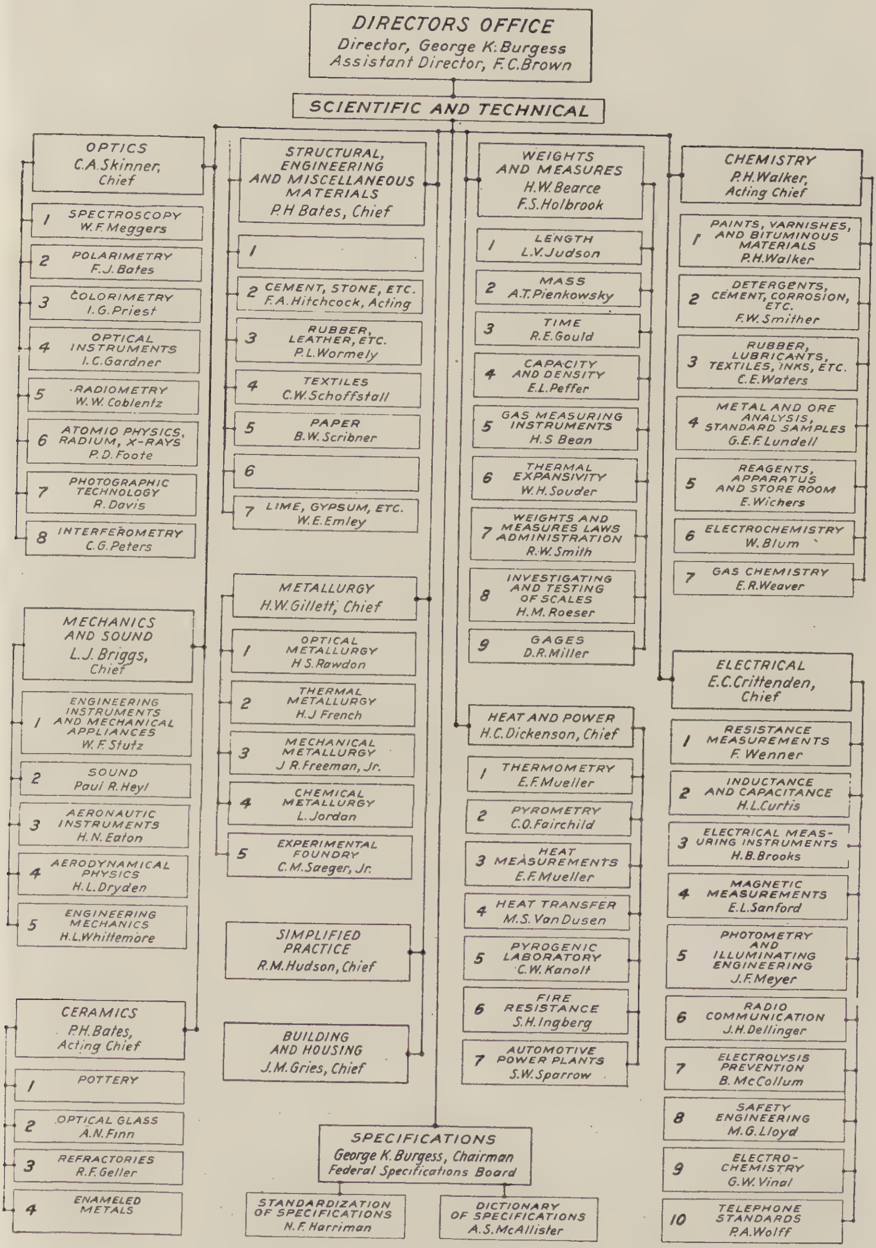
The National Terra Cotta Society for a number of years has been supporting a research associate at the Bureau with the object of securing and maintaining a quality of architectural terra cotta which will give the best performance of this ware in buildings

The physical properties of terra cotta have been determined, including compressive strength, transverse strength, tensile strength, resistance to freezing and the coefficient



of expansion. The tensile strength, as compared with building stone of like absorption, was found to be high. Investigations of the expansions of the glaze, body and underslips have also been undertaken. The coefficients of expansion of 20 samples of each on these materials have been measured by the interferometer method. Crazing of

ORGANIZATION CHART
OF
THE BUREAU OF STANDARDS
Revised to June 18, 1925



the glaze in some cases was found to be due to the glaze having a greater coefficient of expansion than the body.

In order to study the serviceability of this ware in buildings, terra cotta which had been in service 2 to 30 years was examined critically on 535 buildings in practically every large city in the United States east of Kansas City, Mo. It was found that terra cotta must meet certain requirements in climates having freezing weather. Keeping water out of terra cotta structures by proper flashing was found to be beneficial, especially where steel which would otherwise rust is used in the structure.

An investigation of manufacturing methods, with the object of standardizing manufacturing practices in so far as these affect the quality, included a visit to 14 terra cotta plants. The good and poor practices employed by the different plants are being pointed out to the industry. The economic value to the public of improving the quality of the ware in this manner is inestimable.

Other research on terra cotta consists of a study of eight ceramic bodies, including four commercial terra cotta bodies. Twelve different ceramic finishes were used on the specimens and all of the test pieces were made at terra cotta plants in accordance with standard practice. Outdoor service tests are being conducted on specimens molded in the shapes of balusters and coping. In addition to these, laboratory tests are being conducted on the same bodies. It was found that the methods of firing and cooling terra cotta and the types of kilns in which they are fired have a decided influence upon the quality of the ware.

Twenty cements are being investigated to determine their suitability for joining pieces of terra cotta. It was found that some of these cements produced very good joints, the most promising being those of the zinc-oxychloride type.

Adhesion of Mortar to Brick

Comparatively little work has been done on the adhesion of mortar to brick although it has been recognized that the bond between mortar and brick is a factor contributing to the strength and performance of masonry. The problem, therefore, of determining the effect of various kinds of mortars for use with sand-lime brick was taken by up the Bureau.

The total absorption and rate of absorption have been determined for 1100 sand-lime bricks, so that they can be arranged in groups of different absorptive capacities. In general, bricks of the highest total absorption show the most rapid rate of absorbing water.

Tests were made with a 1:3 cement mortar, where the percentage of water was varied, both in the bricks and in the mortar. Where the bricks were used dry, the mortar adhered to the first in contact with it. Where the brick were wet, the mortar adhered to the second brick. The results show that the strength of the bond between cement mortar and bricks is greater when bricks are wet rather than dry and when the mortar itself is quite wet.

SOCIETY OF GLASS TECHNOLOGY

The May meeting of the Society of Glass Technology was held in London and was devoted to a Symposium on the Constitution of Glass. Two sessions were held at both of which members of the Faraday Society, the Optical Society, and the Physical Society and others interested in the subject, were present. At the first session on May 25th, the President, T. C. Moorshead, was in the chair, at the second on May 26th, the chair was occupied by F. G. Donnan, President of the Faraday Society.

The following papers were presented:

I. The Nature and Constitution of Glass

By W. E. S. Turner.—The abnormal properties recently observed in glass when heated in the annealing range (properties including greatly increased thermal expansion, heat absorption, and modification of specific electrical conductivity; and the changes of density and refractive index on heat treating glass) had their counterpart in the charges of plasticity which glass exhibited when remelted or when the raw materials had considerable quantities of moisture or of certain salts present. Two fundamental factors must necessarily be involved in any explanation of these phenomena, namely: molecular complexity and the presence of compounds in glasses. The author proceeded to discuss our knowledge of these two factors in glasses and to suggest explanations for the behavior of glasses.

II. On Glasses as Supercooled Liquids

By G. Tammann.—In the absence of the author, a translation of this paper by J. H. Davidson was presented by F. F. S. Bryson. A discussion of the influence of degree of undercooling, nucleus number, viscosity and other factors on the production of the glassy state. The customary soda-lime-silica glasses might be regarded as ternary mixtures of Na_2SiO_3, $CaSiO_3$, and SiO_2. The two components Na_2SiO_3 and $CaSiO_3$ crystallized readily, as did practically all metasilicates, and this also applied to their mixtures, from which mixed crystals separated. With an excess of silica the nucleus number of these mixed crystals was reduced extraordinarily, so that mixtures with an excess of 8% of silica or over solidified as glasses.

III. On the Constitution and Density of Glass

By A. Q. Tool and E. E. Hill.—This paper was presented for the authors by E. A. Coad-Pryor. The condition of a glass was one which was intermediate between the liquid and solid states. Its condition at ordinary temperatures might be considered as under-cooled not alone with regard to the process of crystallization, usually known as the true solidification, but also with respect to the completion of many processes normal to the vitreous condition. Experimental data on the variation of density and of refractive index of a glass through heat treatment were quoted. The maximum density change observed was 1.10.

IV. The Ternary System Sodium Metasilicate—Calcium Metasilicate-Silica

By G. W. Morey and N. L. Bowen.—This paper was presented for the authors by N. W. Travers. The following new compounds were found and their properties determined: the compound $2Na_2O.CaO.3SiO_2$, which melts incongruently, forming a liquid richer in Na_2SiO_3 and $Na_2O.2CaO.3SiO_2$; the compound $Na_2O.2CaO_3SiO_2$, which has a congruent melting point at 1284°; and the compound $Na_2O.3CaO.6SiO_2$, which melts incongruently at 1045° forming a mixture of wollastonite and a glass containing approximately 15% CaO, 67% SiO_2. The melting point surfaces of the various unary, binary and ternary compounds existing as solid phases had been determined, and the results were given in tables and curves. The relation of the facts discovered to speculations on the constitution of glass was discussed.

V. X-Ray Diffraction Measurements on Some Soda-Lime-Silica Glasses. (A Preliminary Note.)

By R. W. G. Wyckoff and G. W. Morey.—This paper was presented for the authors by Miss V. Dimbleby. In some instances the broad bands thought to be char-

acteristic of glasses had been found. In others, however, narrow bands or lines had been obtained which were as sharp as the lines produced by crystals of colloidal dimensions. Sometimes only one such broad line was observed, in other cases the pattern consisted of several such lines. In still other instances the photograph from a single glass was a composite of lines and broad bands. The positions of the lines were sometimes different from glass to glass, though frequently several glasses agreed in having lines in the same positions. An extended discussion of the results was deferred until many more glasses had been examined.

VI. The Structure of Quartz

By William H. Bragg.—The author observed that the problem of the structure of quartz was one of the first to be attempted some 12 years ago, when the X-rays became applicable to the examination of crystals and a partial solution was obtained. The data, however, did not completely fix the positions of the separate atoms of silicon and oxygen. Four parameters still remained to be determined. One of these referred to the position of the silicon atom, the other three to the positions of the oxygen. The object of the present paper was to describe a new plan based on the fact that quartz changed its structure on passing through 575°. The high-temperature quartz was more symmetrical than the low. A number of considerations showed, however, that the change was not severe and that if the high-temperature structure could be found, the low-temperature form was not very different. The four unknown quantities reduced to one on passing to the high temperature form; the silicon atoms are fixed, and the oxygen atoms must lie on certain straight lines. Attempts to fix the positions of the oxygen atoms could be made, based on intensity measurements. The most probable value showed somewhat unexpectedly that each silicon atom was at the center of a regular tetrahedron of which the four corners were occupied by oxygen atoms. If it was assumed that the low-temperature quartz was not very different from the high-temperature quartz as determined in this way, the various twinnings of quartz were readily accounted for.

VII. The Viscosity of Glass

By Vaughan H. Stott.—The results of a critical study of the measurements of E. W. Washburn and G. Shelton, and of S. English has been recently published by H. Le Chatelier. In the present paper these measurements were reconsidered in conjunction with some additional determinations which had been carried out at the National Physical Laboratory. If it was desired to obtain final relations between viscosity and composition, in which errors due to impurities or inaccurate compositions generally, were not considerably greater than the errors of the viscosity determinations themselves, it would be necessary to prepare the glasses from materials of known purity and melt them without contamination. This procedure, which at present precluded the melting of large pieces of glass, would limit considerably the design of viscosimeters.

MEETING OF THE ST. LOUIS DISTRICT ENAMELERS CLUB

The members proving again their interest and confidence in the Club attended in a number of 31, also three guests, two of whom, Messrs. Eppstein and Wilson, representing the local Laclede Gas Light Company, and the speaker of the evening, R. A. Weaver, of Cleveland, Ohio.

Mr. Weaver, or just "BOB," as the enamelers will know him, has with his Friendship, we may say, honored the Club, and to him the Club extends its sincere thanks and appreciation for all he has done toward getting it known, with reference to the *Enamelist.*

Preceding the regular business meeting a dinner was served, the only complaint being that it was not served in Belleville. The Belleville Boys, however, tried to conceal their feelings by reading to the Club a paper on "The Function of Manganese Dioxide in Ground Coat Enamels," and succeeded brilliantly, because the subject opened wide and lively discussion, thus setting in the background everything else.

Gus Oesterle and F. S. Markert of the Belleville Enameling & Stamping Company well deserve credit for this excellent paper, of which the contents in short follow:

Manganese dioxide is generally used in the ground coat enamel in the amount of from 1–3% to the raw batch weight. It acts chiefly as a coloring agent and is economical to use in replacing the cobalt and nickel oxides, which are much more expensive. Dependent upon the amount used, manganese dioxide varies in color from a drab green to a violet color. Also the use of borax and bone ash with it has influence over the color of the ground coat enamel. In order to obtain a uniform and dark colored ground coat, cobalt, or nickel oxide should be added.

Manganese dioxide affects the physical properties of the enamels as follows: It gives good gloss to the enamel. Harder enamel is obtained with less danger of overfiring. It reduces the coefficient of expansion of the glass it is used with. Adhesion of the ground coat to the steel is same as when cobalt is used. Has no apparent effect on chipping of the enamel.

The paper has been based and worked out on the experience Mr. Oesterle has had in his shop.

Another paper on dipping was read by B. T. Euler of the Buck Stove & Range Company describing their dipping devices and experience.

Their method to test enamel for proper set, which has proved satisfactory, follows:

Using a piece of steel exactly two feet square, should be dipped in ground coat enamel when particularly good results are obtained. If the enamel has drained the piece of steel should be carefully weighed to the accuracy of $^1/_{16}$ ounce. Having arrived at the weight of it, it will be easy to set up the enamel, using the same piece of steel for testing the enamel about twice a day.

Borax solution should not be used in the ground coat enamel, but instead add 1% crystal borax to the mill.

Reports of the various committees were heard. F. Stretch, Chairman of the Membership Committee announced that he received from H. J. Swope, general manager of the Economy Enameling Company, Quincy, Ill., application for membership. The application was unanimously accepted and with great pleasure a new member's name has been added to the roster of the Club.

Section "Q" opened every field of discussion as usual. The most important question is still the oldest one "When will the time come when FISHSCALES will be obsolete?" The question was not answered entirely satisfactory and there is no doubt but that it will come up again.

The meeting was adjourned for the hot summer months until September.

CALENDAR OF CONVENTIONS

Organization	Date	Place
Am. Assn. Advancement of Science	Dec. 28–Jan. 2	Kansas City, Mo.
AMERICAN CERAMIC SOCIETY		
(Annual Meeting)	Feb. 8–13, 1926	Atlanta, Ga.
(Fall Meeting)	Oct. 1, 1925	New York City
Am. Electrochemical Society	Sept. 24–26, 1925	Chattanooga, Tenn.
Am. Engineering Council	Jan., 1926	

Organization	Date	Place
Am. Foundrymen's Association	Oct. 5–9, 1925	Syracuse, N. Y.
Am. Gas. Association	Oct. 12–16, 1925	Atlantic City, N. J.
Am. Inst. of Min. and Met. Engineers	Aug. 31–Sept. 5, 1925	Salt Lake City, Utah
Am. Soc. of Mechanical Engineers	Nov. 30–Dec. 3, 1925	New York City
Am. Zinc Institute	April 27–28, 1926	St. Louis, Mo.
Assn. Iron and Steel Elec. Engineers	Sept., 1925	Philadelphia, Pa.
Coal Mining Institute of America	Dec. 9–11, 1925	Pittsburgh, Pa.
Common Brick Manufacturers Assn.	Feb. 22–26, 1926	New Orleans, La.
Mining and Met. Society of America	Jan. 12, 1926	New York City
Natl. Association of Manufacturers	Oct. 26–28, 1925	St. Louis, Mo.
Natl. Exposition of Power and Mechanical Engineers	Nov. 30–Dec. 5, 1925	New York City
Natl. Exposition of Chem. Industries	Sept. 28–Oct. 3, 1925	New York City
Natl. Paving Brick Mfrs. Assn.	Jan., 1926	
Natl. Safety Council	Sept. 28–Oct. 2, 1925	Cleveland, O.
Optical Society of America	Oct., 1925	Ithaca, N. Y.
Sand-Lime Brick Association	Feb. 9–15, 1926	New Orleans, La.
Natl. Society for Vocational Education	Dec. 3–5, 1925	Cleveland, Ohio
Natl. Exposition of Coal Mining Machinery	Dec. 2–5, 1925	Cincinnati, O.

BULLETIN

of the

American Ceramic Society

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific and Art Questions and Promotion of Coöperative Research

Vol. 4 — **September, 1925** — **No. 9**

EDITORIALS

USES OF CERAMICS IN INTERIOR DECORATING

An Interview with Lionel Robertson of Tobey Furniture Co.

By Myrtle Meritt French

Too often a producer manufactures without knowing exactly what is needed and then wonders why his ware does not sell. Meanwhile those who would naturally be using the product are buying from foreign nations, after giving up hope of finding in this country articles of the desired quality. An interior decorator in the John Smyth Furniture Company told me sometime ago that his concern keeps at least one man abroad the year around buying pottery for their work, because artistic enough things are not available in this country. What is true of one company is doubtless true of another. If the statement is correct we have it within ourselves to rectify it. In many instances, both the producer and consumer blame the "other fellow" for the situation, but the only way to make amends is for those concerned to get together. Here is a new kind of research which is needed worse than almost any other in the ceramic field. After all, the producer (and most of us are producers) is more vitally interested than the consumer and therefore should take the initiative. The first step is to discover what our would-be consumers could use.

Knowing that Lionel Robertson of Tobey Furniture Company is extremely interested in uniting the efforts of the artist with those of the in-

dustries and that he has already accomplished much along that line, I asked him to tell how he is using ceramics for interior decoration. Generously, he told of his very definite ideas as he is working them out so successfully in the homes of Chicago.

"Pottery is one of the most valuable items used in making up a beautiful composition for interior decoration. In planning a composition a decorator must play up to contrast. It is that interesting play of contrast of one against the other that gives life to the whole room. That is, contrast of color and contrast of texture, which is equally necessary. Here is where ceramics plays an important rôle. We have our rugs, furniture covers and curtains, which have softness of texture; ceramics comes in with hard glazed surfaces and gives an interesting contrast thereby. Too, a strong pure color note is often so necessary to give a room an accent, and there is no better way to secure it than to use a lamp-bowl in some strong pure color with a glazed or semi-glazed surface. The usual error is not having them of sufficient bulk to be in proportion to the shade and other furnishings of the room. When metal lamp bases are used, it is consistent to make them slender, but the pottery should be round and bulging with the curve giving a counter swing to the line of the shade. It required a great deal of judgment to use a decorated lamp bowl as a base combined with a shade, since usually the shade with its trimmings has sufficient interest without a decorative pattern on the base. When bowls or vases are to be used as ornaments, then the decoration can be elaborated according to the simplicity of the background.

"I always feel that pottery for interior decoration can be roughly divided into two large divisions. First the classical type, of which the Wedgwood ware is an example, where its classical Greek curves and cameo ornament go so fittingly with a classical interior such as a Georgian Colonial or Louis XVI French room. There are some Roman and Pompeian forms in the recently arrived Italian wares, which make interesting spots of color in this type of room. Then there is the interior of the style of Louis XV in France and Queen Anne in England which has a flavor of romantic luxury; here the Chinese and Persian pottery blend most harmoniously. This is the beginning of the second type.

"In the early English and Spanish interiors, which are so popular with our small homes today, the peasant ware from France and Spain blends most consistently with the rough plastered walls, turnings of chair and table legs and the gaily colored upholstering.

"Majolica wall vases and jardinieres used sparingly make an interesting decorative note. The iridescent ware which depends on its graceful silhouette and subtle coloring is most effective in this type of room.

"It is very interesting to observe the reminiscence of old Roman forms in the Italian peasant ware. They seem to be vaguely remembered from

some racial impression of the past and naïvely expressed in the crude earthenware. The same is true with the Spanish peasant pottery—always just a flavor of the old Moorish. In the French peasant ware from Brittany, the pastoral scenes in their yellows and blues are really a free interpretation of what was more elaborately done for Marie Antoinette. It is natural that a people should express a certain racial flavor in the great works of their past.

"This opens up a most interesting vista of what we, as Americans, are going to develop as a racial flavor in the pottery we are making. It is pleasing to note that the Rookwood and some of the pottery from Zanesville and East Liverpool, Ohio, are really graceful in form. The Pewabic Pottery made in Detroit, Michigan, has been very carefully thought out as regards shapes, colors and glazes. The marvelous collection of Syrian shapes dated about 3000 B.C., and owned by Mr. Freer were placed at the disposal of Miss Perry when she was first working out the Pewabic destiny. Her work is more for people who understand the possibilities, limitations and ideals in pottery; it will never be commercial and popular.

"But the pottery which gives me a real emotional sensation is the Indian pottery of the Southwest. The shapes and colorings seem to come from the inner consciousness of a simple Indian and have a fundamental quality of design, which cannot be found in the more sophisticated East.

"They tell us we are developing a national architecture in the sky scrapers of the last few years. They are quite simple and fundamental in silhouette and composition. Can we not hope from this that the national flavor we give our ceramic design will eventually have this same simple fundamental quality? At present it is not a free expression like that of the foreign pottery; it is too self-conscious, too obviously made to sell.

"I have always been much against an artist decorating a piece of pottery which he has not fashioned himself. There is such an intimate relationship between the shape and decoration that it is quite fatal to divide the inspiration by having two people work—one on the shape and one on the decoration.

"The chemistry involved in the colors and textures of the glazes must be most fascinating. I have dreamed of getting old and retired and being able to take up pottery as an avocation, for I consider it one of the most fascinating of the applied arts."

For the thoughtful ceramist, there are many suggestions in Mr. Robertson's remarks. Doubtless the most important point, and one which is difficult to solve is the establishing of a type of pottery which is really beautiful in form, line, decoration and color, and which has an American flavor. That means the finest of American life and ideals must be expressed in a simple, beautiful, practical way. To do this, trained artists, knowing something of ceramic technique, must guide the art side of production.

Already, there are a few trained people in the country, but more are needed. Every ceramic school should have an art course. Even the engineers should be trained to judge whether a thing has beauty—though they may not be able to create designs. Our art schools should apply the original expressions to materials, one of which would be clay.

The potteries should send their self-trained artists to get an understanding of the principles of good design; also they should use to advantage the few who already understand both design and ceramic technique. All these suggestions introduce other problems which would have to be solved along the way. It will take time but it must be done sooner or later.

A buyer in one of the best and largest china departments in the United States told me he buys most of his stock from Europe, because the ware is more artistic and original. He added that very few of their customers like the American china with the exception of the Lenox ware. When I left his office, I requested a salesman to show me the china. Immediately, I was taken to the imported products. One table was filled with refreshment sets for bridge parties. The ware was stamped on the bottom "Made in Japan." Do the Japanese play bridge? If not, why was it made there? Upon request to see the American ware, it was explained that they *do* carry it, but of course it is not as beautiful as the foreign ware. With the exception of the Lenox, it was all in a small back room. As we entered, the salesman picked up a plate saying, "This is the most attractive pattern, it is a copy of an Old English."

American copies of foreign art lose the beauty, because the inspiration is gone. We *must* express *ourselves* in an artistic way if we are to compete. Naturally, American expression if beautifully produced would fit our homes and tastes better than foreign production. We must meet the situation, for the public is being taught to choose the most beautiful. The need will be the greater when the "American style" of home develops as it has already started to do.

ART INSTITUTE OF CHICAGO
CHICAGO, ILL.

AMERICAN CERAMICS FOR INTERIOR DECORATING

The Silver Lining in the Cloud

By PAUL E. COX

There was once a lodge known as the Order of Humility. A person worthy of being an active member of this lodge had to have the quality of humility developed to the point where he was perfectly comfortable in the lodge room when seated on the bare floor, since chairs and pride went hand in hand. Americans are in danger of active memberships in this

uncomfortable Order if they fail to see the fine things done by Americans as well as the poor things, and particularly is this true in ceramic products.

Certainly we make our share and more, of trashy ceramic products and it is good that we are to be lifted out of this habit of ours. But Europe, and likewise China and Japan, are not more free from fault than are we.

A cultured man traveling in Italy was pleased by the Neapolitan street songs. Most people who live abroad are interested in the songs played and sung on the streets of European cities. He brought back a collection of these songs and a very competent musician played them over for him and his friends. They had the plaintive quality of street songs the western world over, and a listener remarked that they were so much better than American songs of the street. The musician remarked that nevertheless they were just Italian trash and of brief interest just as are our own. There is likewise foreign trash in ceramic products just as there is trash in domestic products.

On the whole it is probable that we do better in ceramic wares than we do as musicians in the final balance sheet of the nations.

Of course there is no defense possible for most of the white table ware produced in America. But neither is there any defense possible for the paper plates, spoons and forks, used at an American picnic lunch. There is not an artistic thing about paper table service. There are markets, however, for both types of table services because they are cheap, do the work for a time proportionate to the cost and so serve their purposes well enough. People are careless in small purchases and most American whiteware finds its market with the small purchaser.

But two or three American manufacturers have set out seriously to supply table services that compete on a quality basis with imported wares and in those cases they have made pace right along.

As long ago as the Columbian Exposition the wares made by James Pass would stand more hard knocks than those of any competitor, the authority for this statement being Charles F. Binns, who told the writer the story of the contest twenty-seven years ago. American potters have excelled in the development of wares suited to institutional uses and the quality of decorations has been proportionate to the quality of the body and glaze in most cases.

Lenox china needs no comments.

Ceramically speaking the best "little boner of childhood" in America is that Haviland china is the most desirable white table service in the world. So long as the American housekeeper believes that the possession of a set of Haviland marks her as the person knowing what is what, we shall have no demand for better work by American potters, because now we have for Sunday and other feast days a set of Haviland and for work days a set of domestic that looks like Haviland "but is not so thin and is not translu-

cent." For breakfast in the faddy little breakfast alcove we have the set with blue birds on it that we got at the dime store.

Anyhow most folks have quit buying dinner services, because they hop into the flivver as soon as evening comes, taking their friends along and entertaining them away from home. Some of the old pride in household fittings is being expended on the family car, and the cheap but carelessly made dinner service is the one that is bought.

The restaurant man, however, has to buy more carefully for this same reason, and as a consequence we have in America the best hotel ware that is manufactured. Those American universities that offer courses in household economics need not have pangs of conscience when the teachers endorse American made hotel wares for home and institutional use.

American floor and wall tile plants have not dropped behind in the race with the foreigner. It is true that there is a softness in color and line in the decorated tin-enameled tiles of Europe that we need to learn to appreciate and to imitate but likewise there is another sort of softness in the body of those tiles that we know better than to permit in our own better manufactures. The employment of a few artists who possess the tact to coöperate and to work in industrial fashion with our very capable engineers will put us far in the lead in this important ceramic field. The work of Rufus B. Keeler reported in a beautifully illustrated article in the July number of this *Bulletin* on the Use of Clay Products in Modern Homes shows what can be done when the ceramic scientist and artist coöperate.

In terra cotta we have done well, but we can do better when we follow the lead of the tile makers and produce our wares with a dense body. This would be of the "grés" type, in the method demonstrated by Sèvres at least three decades ago. There are, however, buff burning clays in many places that will produce dense products at the low temperatures used in American terra cotta and the warm palette asked for by the architects could be had, coupled with low absorption values. There are architects who believe that they, themselves, are to blame for the failures, artistically, in the use of terra cotta, since the terra cotta manufacturer works so largely on specifications furnished by the architects.

This brings us to the field in ceramics in which Americans excel.

It is not fair to name these little enterprises because the list is so likely to be far from complete. Nevertheless the point can best be made by naming a list of small concerns making wares of such perfection that no American need be ashamed to possess them and to place them in company with ceramic products of any country and of any time.

Rookwood, Newcomb, Van Briggle in the days of the Van Briggles, Volkmar, Grueby, Overbeck, Pewabic, Cowan, Marblehead, Walrath, Binns, Mrs. Frederick Rhead, Rhead, Thomas and Bragdon, Joseph F. Meyer, George Ohr, Maude Robinson, Mrs. Bentley Nicholson, Stull,

and many others who have worked or are working, make a list of firms and individuals that differ markedly from a similar list of European potters, because for the most part the European potter is a man of traditions while these people took tradition and improved, because most of the above named persons are workers for the love of the business and are, for the most part, college bred.

There is no thought that the list is complete enough to be fair but it is complete enough to make the points.

Rookwood can furnish any color wanted by any decorator and decoration of any quality and of most periods. The Rookwood staff is as well equipped intellectually as is any staff of any pottery abroad.

Newcomb School of Art has been the most faithful producer of individually designed pottery, I think, that ceramic history can show. That is, there are no duplications of the designs.

Since the Van Briggles were Rookwood decorators, their story is simply that of the Rookwood but they did not have the facilities for technical perfection. Volkmar serves us best to show us what type of man we ought to bow to in improving our more commercial types of wares. Any collector of ceramic wares ought to want his products. Those interested in glaze textures can find in Grueby as interesting things as they can find abroad, and I believe that the Grueby genius has been now transferred to that little pottery at Keene, New Hampshire. The Overbeck sisters are modest in their output but the wares they offer are honestly and faithfully made and their skilful use of both body and glaze in securing of color effects makes their ware as interesting certainly as a foreign product. The Pewabic tiles did not fail to interest architects for ecclesiastical decoration where European made tiles could have as well been used so far as cost was concerned. Cowan makes some lustered white wares that do carry an individual note in this rather hackneyed treatment, so that I think that those who enjoy lustered wares like those of the Ruskin Pottery will find Cowan not far behind at all. Marblehead has for twenty-five years produced a line not to be excelled by any importation and Arthur Baggs has shown some things in lively color that ought to please any decorating firm in the land, these pieces being unsophisticated. Walrath made a good many pieces of merit and had the temperament to produce a line comparable with the best that comes from abroad and a fondness for working alone so that from him we had a sort of college bred peasant pottery. His early death robbed us of much. Professor Binns has fathered more studio potteries than any other American and it has been a splendid thing for us that he left England to become an American citizen and to make his American stoneware. Most surely any decorating firm could find what they want for large colored bits in their scheme of decoration from the line he has produced, and Professor Binns has not reserved this field to himself

if any manufacturer pleases to take it on. Mrs. Frederick Rhead working with Mr. Rhead produced pâte-sur-pâte of such excellence that we know we do not absolutely have to import that type of ware if a more commercially inclined person should want to produce this in America. Rhead has produced many fine vases of all sorts, of exactly the type wanted by house decorators. Thomas and Bragdon have worked on small bowls and tiles in colors suitable for the house decorator. Meyer, the Newcomb potter, has made pottery under the plan of the Italian luster workers of such merit that a gold medal came to him from the St. Louis Exposition. He has not made this ware for sale because he is a simple craftsman, and not a business man. George Ohr, of Biloxi, made many pieces as interesting as can be had from abroad but his eccentricities robbed him of the fame he craved. Some considerable portion of his wares are still to be bought from his widow and a discriminating collector could pick up some choice bits, I think. His work was certainly as interesting as is the work of any European peasant. Miss Robinson has been making wares of interest to New Yorkers, and for people who can buy abroad if they prefer, while Mrs. Nicholson chose the field of the majolica makers and produced the low temperature copper reds. R. T. Stull made the crystalline glazes almost as early as they were produced in Europe, and some of Stull's crystals are better than any I saw at Sèvres in their museum collection.

Now the point to all this is that we are really independent of foreign ceramic goods if we want to be and we need to know that we are. Unfortunately our schools of art educate their students away from work in the factories so that in America we have few good designers interested in any way in ceramic wares in the factories. We have too many persons standing off and preaching at us while we need the same persons in the plants with the sleeves rolled up and doing their missionary work for just plain pelf. The engineers from the colleges have done their work well because they got into the plants and into the jobs.

The city of Paris has just as rich a market for trashy French pottery as has the city of Chicago for trashy American pottery, and for similar reasons which are reasons very human in character, folks over there buy cheap dishes, usually less sanitary in use than our own because less well made.

We need the artists in our potteries as well as all our industries and the ceramic engineer must learn to tolerate the artist and the artist must learn to tolerate the engineer. But we need them to make our own wares better and not because we are more rotten than our friends across the Atlantic. We need to hire American artists and to make our wares in American ways and our house decorators need to think out schemes of decoration that are American and to use our very excellent American decorative pottery. I spent many days in the Sèvres plant and learned that several of our American art potteries are more careful even than they are at Sèvres

and that many of our designers are equally well trained and equally skilful. I had to live in France to learn how well we do our ceramic work in our smaller factories and studio concerns.

AN IDEAL ENDEAVOR IN SCIENCE AND ART

By Karl Langenbeck.

The vision of Professor Orton in enlisting the few who had already had systematic training in ceramics, and those who sought knowledge to supplement their practical experience, has borne generous fruit in the amazing development of our Society. We have a sodality for mutual support and an ideal of generous helpfulness to advance our profession second to none. Have we beaten an open road of endeavor, in solving practical problems for the benefit of all, that is sufficiently satisfying to be exclusively followed for the next twenty-five years?

A profession is merely a livelihood. Numberless pressures force us, day by day, to leave it at that. Can we remain satisfied with the usufruct and incidental search for immediate practical solutions, however generously shared?

A Plea for Fundamental Science Researches

The tools of our professional thinking, practical experimentation and industrial applications are derived from chemistry and mechanics. We surely owe these sciences the only possible return that can be made, namely, extension of their boundaries along the lines of our specialty, the fabrication of silicate wares.

But we are pushed by practical problems. We must satisfy commercial associates, whose stock suspicion is that we may be spending time on things that do not pay. A set determination to spend some of our time, thought and work on purely scientific questions, will involve moral courage in demonstrating the practical value of purely scientific researches.

Is it not well to prove to ourselves that we will not slip down the easy path of becoming wage slaves, toward which we are insidiously headed?

Chemistry, as science, is an organization of laws of the things unseen, which underlie the phenomenal. Electrons, atoms, molecules, compelling creations of the mind, are the substance of its systems. They are invisible noumena, more concrete than the shifting and confusing phenomena, which we observe, and they cause.

The chemistry of the fluid or plastic silicate solids is barely known. For to be chemistry in any real sense the degree must be measured and shown to which the laws of stoichiometry, of surface attraction, mass action and osmosis separately determine the observed phenomena of colloids. Only then can it function as science.

We can all weigh, measure and calculate. We can all determine to be

"hod carriers of science," as Huxley said, and gather the brick for this structure to be reared. What we must severally determine is to resist the constant pressure of the immediate and practical to the extent of reserving some time for thought and measurements on clear cut lines of chemical and physical laws.

We should think and search in a spirit of complete detachment and without utilitarian aim. Each one of us, so minded, can contribute something. In doing this let us cling confidently to the belief that some one of our number with breadth of vision and penetration of discernment for the essential will build from such data this branch of chemical science to the general honor of our SOCIETY and to the fruitful use of the world.

Is it too much to believe that our SOCIETY can bring forth a van't Hoff, an Arrhenius or a Willard Gibbs? The personally little rewarded labor of a "hod carrier of science" will appeal only to those of us with a strong scientific bent.

A Plea for Art Researches

To the buying public the largest proportion of ceramic products appeal for their attractiveness and cultural quality. If my appeal for reserving some of our time and interest from purely professional endeavor has any weight, they can be exercised in seriously studying our wares and learning from artists, what constitutes good taste and what are the ear marks of the shoddy.

Remember that pottery, the first of the arts employing fire, became a mode of expression and the vehicle of taste for primitive man almost as soon as it was a practical craft. With glass it was no less the case.

To the ethnologist the ceramic products of a people are among the most important data of its culture. So also from the dishes and bric-a-brac in the house of strangers, the ladies of your family arrive at a shrewd opinion, as the colored servants put it, "da's of de quality."

The women are the buyers of every family, and make also the main body of the students, amateur practitioners and patrons of the decorative arts. On the other hand, in painting, architecture, landscape gardening and the larger decorative work, appreciation and interest are no longer so one-sided, and women themselves have improved in taste with the growth of masculine interest in these.

These facts being demonstrable, can we afford to give but tolerant, casual attention to questions of original, artistic creation, which is the larger part of ceramics to its buyers?

There is an excuse for this undeniably cavalier attitude in a profession based on science. It feels that its work is worth while because it is founded in eternal verities and decorative art, though it seems to many of us a matter of fads, a thing of personal preferences, which suits one if it does not suit another. A sympathetic interest and some study will reveal to

us that this is not true. Running through all modes of human expression in art, as in literature, there are fundamental criteria of quality, of taste, as certain as the laws of science. They are felt in every representative example of the decorative art of every epoch. The distinction from scientific laws is that they are qualitative. Each generation varies the emphasis and proportion according to its need and habits, because they are laws of the human species and not of indifferent nature.

The opportunity for this broadening of interest and education is already laid through the able work of Mr. Rhead, Miss Sheerer, Prof. Cox, and others within our SOCIETY and by the experimental work and teaching of Professor Binns. I can only emphasize the importance of their work and point out an ideal into which it should culminate.

A ceramic society, however successful professionally, will be a barren affair in the eyes of consumers if it does not evolve men capable of selecting and directing artists and adapting technical facilities to produce glass and pottery wares new in conception and worthy of the taste of the time. As long as designing in our shops is left to trade craftsman, moldmakers, decalcomania lithographers, however clever, it will always remain imitative.

What is needed is a gamble in fresh blood. You are the men to do it, but you have to train yourselves for it. Josiah Wedgwood achieved what he did by engaging the sculptor John Flaxman, a thing unheard of in English potteries. Ag amble like this pays and I wish to remind you that the American pottery and glass which have achieved reputation did so on this basis.

In hoping that many of you will strive for command in this direction, the reputation of our SOCIETY will ultimately stand out, I am sure, in bringing forth a Della Robbia, a Wedgwood or a Theodore Deck.

AMERICAN CERAMICS

BY ROSS C. PURDY

Much has been said and written lately about the relative merits of ceramic ware produced on this continent and in Europe. Broad statements have been phrased but actually intended only for limited types of ceramic ware. These statements have been given not in a manner mean but with the purpose of getting to the facts.

The citations may show a lack of information; they may disclose prejudices on part of the buyers and they may appear to overlook commercial considerations but no inference should be drawn regarding the writers' opinions of the ability of the American ceramist to produce. The ability and resourcefulness of the American ceramists have not been questioned.

Certainly American manufacturers of ceramic ware are fully aware of the market demands, the foreign competition and the commercial factors

involved, and the manufacturers are so managing their plants as to produce the highest quality of ware and the best of ceramic art compatible with the economics as they appear to be of the prevailing trade and labor situation.

There would be decadence if manufacturers did not frankly study the problems of competition in quality and artistic merit as well as those of commerce. A bald statement of facts will be beneficial though not always pleasant, and certainly not always understood. We ask that the statements made be accepted as honest efforts to present those phases of the situation which appear most prominent to the writers. No one has attempted to sum up the case for all the evidence is not before them. No one is attempting to placard nor to give alibi; they are simply giving testimony because they have a deep and sincere interest in American ceramics.

Broad statements covering the relative merits of all American ceramic ware cannot be made. Although the science (silicate chemistry) of ceramic compounding, and the technology (applied physics and chemistry) of ceramic fabrication are basically the same, ceramic products differ widely in kind, use and properties. Ceramic products include those made with clay, glass and vitreous enamels. In general all of them are made by fusing minerals and metal oxides to form silicates, each sort or variety of ware being made to have different serviceable, protective or decorative properties. Any statement to be of value or in truth regarding relative merits of ceramic products will have to be definitely limited to a given type, variety and purpose.

Glass containers will differ in quality of glass, perfection in molding and in design according to the need in each of these respects to satisfy service and esthetic demands. So it is with china, majolica, terra cotta, brick and all other ceramic ware. For that matter, this is also true in all sorts of utility and decorative products. Quality, form and decoration are dictated most largely by their use and by the purchasers' tastes than by the producers.

It is true that the producer can create a product in anticipation of a demand. Purchasers can be trained to want a new article, a better grade or different decorative effect. Why is Toronto a city of brick dwellings, Worcester of three deck frames and Baltimore of batteries of two rooms to a floor?

In art and in utility ceramic ware the producers are ever watchful of the trend in trade demands. Practically nothing worthwhile of foreign make is on the market which cannot here be produced on order. If this continent is not producing ceramic ware of all sorts that are at least equal in all respects to those imported a survey will show the reason to be commercial rather than a lack in ability or resources.

In many lines American ceramic ware are superior in quality and craftsmanship. No utilitarian porcelains are superior to those produced here. American glass and vitreous enameled products are not excelled in any respect, and America is not behind in methods of and equipment for their production. In ceramic construction ware and in refractories, the American products are inferior to none.

The number of art potteries producing original decorative effects is increasing as is the number of tableware plants producing high-grade china, high-grade from the standpoint of quality and art.

Cost of production is a large factor in the case; reflected as it is in the cost to the ultimate purchaser. A great deal of imported ceramic ware is sold below what would be its production cost in America. The purchasers are not impelled by patriotism to buy exclusively "made in America" ware; they are intent on getting the most for their money.

Then too, the products of each country are bound to be distinctive especially in decorative effects, the ware of different nations differing more widely than do the products of different factories in the same country. To secure the largest possible variety in decorative ware, one would make his selection from all countries; but this is not an adequate explanation for a given store not showing American made goods equal in variety, as pleasing in design, color and texture as is produced in any country.

Too much dependence has been placed on tariff as means of maintaining the home trade. There has been too little creative and progressive planning to develop and meet the demand for distinctively American products. There is no reason why American table service should not be the standard of perfection in the minds of American housewives. American potters can, they have and they now are producing dinner ware equal in all respects to any produced elsewhere but a great deal of such ware purchased in this country is not American make. This situation will change as the hotels and restaurants purchase on specifications rather than according to the prejudices of their chefs.

American ceramic ware will have their rightful share of domestic trade when the manufacturers, the schools and the research bureaus are united in determining the quality and character of product required and the methods whereby they can most economically be produced. The science schools will have to stress the essentials in products, and in economical production, and the art schools will have to stress creation of form and decoration. The schools and the research institutes have a responsible share in making strong America's position in the ceramic market, and the purchasing public must be informed. The problem of keeping American ceramics in front ranks is not altogether up to the managers of ceramic factories. There should be a close collaboration of the industrialists, engineers, scientists and artists.

BIBLIOGRAPHY OF CLAY DEPOSITS[1]

By H. Ries

Foreword

In the preparation of this *Bibliography of Clay Deposits* all available sources of information have been consulted, and it is believed to be fairly complete. Many references have also been kindly supplied by the various State Geologists as well as the Directors of foreign geological surveys.

The data have been arranged geographically by continents and countries, under which latter they are arranged alphabetically by authors.

Since fullers' earth, laterite and bauxite are essentially clayey materials, and are usually associated with true clays, they have been included in the references.

Table of Contents

[1] Dr. Ries, a member of the Geological Survey Committee, presents this *Bibliography* as a preliminary to further work by the Committee. Lately there has been considerable interest in classification of clays on basis of similarity in industrial availability. A bibliography of this sort is the necessary first step in such a survey. The compiling of such a bibliography involves wide reading and tedious labor. We know we can bespeak a very general appreciation of Dr. Ries' generosity in making available this *Bibliography*.

NORTH AMERICA—UNITED STATES

Alabama

Brewer, W. M.—The Warwhoop Bauxite Bank, Alabama. *Eng. Min. Jour.*, **55**, 461 (1893).

Butts, Charles—Clays of the Birmingham District, Alabama. U. S. Geol. Surv., *Bull.* **315**, 291–5 (1907).

Chatard, T. M.—Analysis of Kaolin from Greenville, Ala. U. S. Geol. Surv., *Bull.* **78**, 120 (1891).

Chatard, T. M.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228**, 357 (1904).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148**, 282, 292 (1897).

Clark, G. H.—Mica Deposits of Alabama. Ala. Geol. Surv., *Bull.* **24**, 115 pp. (1921).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv. *Bull.* **522**, 72–7 (1913).

Gibson, A. M.—Report on Murphrees Valley. Halloysite. Ala. Geol. Surv., p. 121 (1893).

Hayes, C. W.—Bauxite. U. S. Geol. Surv., *Mineral Resources, 1893*, pp. 159–67 (1894).

Hayes, C. W.—Bauxite. U. S. Geol. Surv., *16th Ann. Rept., 1894–95, Part III*, p. 551 (1895).

Hayes, C. W.—Geological Relations of the Southern Appalachian Bauxite Deposits. *Am. Inst. Min. Eng.*, **24**, 243–54 (1894).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 507 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893*, pp. 611, 612 (1894).

Hillebrand, W. T.—Analyses of Rocks, 1880–1903. U. S. Geol. Surv., *Bull.* **228**, 357 (1904).

Judd, E. K.—The Bauxite Industry of the South. *Eng. Min. Jour.*, **83**, 574–75 (1907).

McCalley, H.—Alabama Bauxite. *Proc. Ala. Ind. and Sci. Soc.*, **2**, 20–32 (1892).

McCalley, H.—Report on the Valley Regions of Alabama. Paleozoic Strata. Part I. On the Tennessee Valley Region. *Geol. Surv. of Ala., 1896*, pp. 68, 105, 180 (1896).

McCalley, H.—Report on the Valley Regions of Alabama. Part II. On the Coosa Valley Region. *Geol. Surv. of Ala., 1897*, pp. 84–6, 177–83 (1897).

Mallet, J. W.—Analyses of White Porcelain Clay from Jacksonville and Randolph County, Ala. *Am. Jour. Sci.*, 2nd ser., **23**, 183.

Mell, P. H., Jr.—The Southern Soapstones, Kaolin and Fireclays and Their Uses. *Trans. Amer. Inst. Min. Engrs.*, **10**, 318 (1882).

Ries, H.—The Clay-Working Industry in 1896. U. S. Geol. Surv., *18th Ann. Rept., Part V (cont.), 1896–97*, pp. 1127–9 (1897).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, 67–78 (1903).

Ries, H.—Preliminary Report on the Clays of Alabama. Geol. Surv. of Ala., *Bull.* **6**, 220 pp. (1900).

Ries, H., Bayley, W. S., and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708**, 82, 128–31, 204–5, 222–3 (1921).

Smith, E. A.—The Cement Resources of Ala. Clays and Analyses. Geol. Surv. of Ala., *Bull.* **8**, 66–75.

Smith, E. A.—The Clay Resources of Alabama and the Industries Dependent upon Them. *Eng. Min Jour.*, **66**, 369 (1898).

Smith, E. A.—The Clays of Alabama. *Extracts, Proceedings Alabama Industrial and Scien. Soc.*, **2**, 33–42 (1892). (Abs. in *Eng. Min. Jour.*, Aug. 22, p. 368 (1893).)

Smith, E. A.—The Clays and Ochers of Alabama. *Eng. Min. Jour.*, **85,** 1088 (1908).

Smith, E. A.—Geological relations of the Clays of Alabama. Ala. Geol. Surv., *Bull.* **6,** 69–113 (1900).

Smith, E. A.—The Portland Cement Materials of Central and Southern Alabama (Clay Analyses.) 58th Cong., 1st Sess., *Sen. Doc.*, **19,** 12–23 (1903).

Smith, E. A.—Sketch of the Geology of Alabama (Porcelain Clays and Bauxites, pp. 5, 23, 24), n. p. (1892).

Smith, E. A.—Sketch of the Mineral Resources of Alabama (Kaolins, Porcelain Clays and Bauxite, pp. 6–7). Published by direction of Issac F. Culver, *Com. J. Agric.* (no date nor place; probably 1897).

Smith, E. A. and McCalley, H.—Index to the Mineral Resources of Alabama (Clays, pp. 33–42) (1904).

Arizona

Allen, E. T.—Analyses of Salt River Valley, Arizona Clays. U. S. Geol. Surv., *Bull.* **228,** 368 (1904).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 90 (1913).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* 526 (1892).

Ransome, F. L.—Bisbee Folio. U. S. Geol. Atlas Fol., No. 112, p. 17 (1904).

Arkansas

Berger, W. F. B.—Bauxite in Arkansas. *Eng. Min. Jour.*, **77,** 606–7 (1904).

Branner, J. C.—Bauxite in Arkansas. *Amer. Geologist*, March, 1891. (Abs. in *Eng. Min. Jour.*, Jan. 24, p. 114 (1891); *Trans. Federated Inst. Min. Eng.*, **3,** 1057 (1891–92); *Jour. Iron and Steel Inst.*, **1,** 275 (1891).)

Branner, J. C.—Brick Clays of Washington County, Ark. Geol. Surv. Arkansas, *Ann. Rept.*, **4** (1888); Geology of Washington County, p. 121 (1891).

Branner, J. C.—Preliminary Report to the Governor of Arkansas on Bauxite and Kaolin. *Arkansas Gazette*, Jan. 8 (1891). (Same reprinted in 3rd Biennial Rept. Bur. Mines, *Manufactures and Agric. for 1893–94*, pp. 119–26, Little Rock (n. d.). Also in 4th Biennial Rept. of same for 1895–1896, pp. 105–12.)

Branner, J. C.—The Phosphate Deposits of Arkansas. (Analyses of Clay Shales, pp. 581.) *Trans. Am. Inst. Min. Engrs.*, **26,** 580 (1896).

Branner, J. C.—The Bauxite Deposits of Arkansas. Contains Bibliography of Bauxite. *Jour. Geol.*, **5,** 263–89 (1897). (Abs. in *Science*, April 30, p. 702 (1897). Analysis in Groth's *Zeits. f. Krystallog. u. Min.* **31,** 298.)

Branner, J. C.—The Cement Materials of Southwest Arkansas. *Trans. Amer. Inst. Min. Engrs.*, **27,** 42–67 (1897).

Branner, J. C.—The Clays of Arkansas. U. S. Geol. Surv., *Bull.* **351.** (Abs. in *Eng. Min. Jour.*, **86,** 1219 (1908). Abs. in *Jour. Iron and Steel Inst.*, **79** [1], 516 (1909).)

Call, R. E.—The Geology of Crowleys' Ridge. (Clays, pp. 86, 108, 138–40; Analyses, pp. 85, 87, 89, 107, 112, 138–39.) Geol. Surv. of Arkansas, *Annual Rept* (1891).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 295, 296 (1897).

Eakins, L. G.—Partial Analysis of Kaolin from Garland County, Ark. U. S. Geol. Surv., *Bull.* **78,** 120 (1891).

Eckel, E. C.—Clays of Garland County, Ark. U. S. Geol. Surv., *Bull.* **285,** 407–10 (1906).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 113–5 (1913).

Fermor, L. L.—Discussion of paper by Wysor, Aluminum Hydrates in the Arkansas Bauxite Deposits. *Econ. Geol.*, **11**, 686–90 (1916).

Fisher, H.—Fullers' Earth. *Min. Ind.*, **9**, 241–2 (1903).

Fitzhugh, G. D.—The Portland Cement Materials of Southwestern Arkansas. *Trans. Eng. Assoc. South, for 1904*, **15**, 33–42 (1905). (Abs. *Geol. Centralb.*, **7**, 589 (1905–1906).)

Hayes, C. W.—Bauxite. U. S. Geol. Surv., *Mineral Resources, 1893*, pp. 159–67 (1894).

Hayes, C. W.—Bauxite. U. S. Geol. Surv., *16th Ann. Rept., 1894–95, Pt. III*, p. 551 (1895).

Hayes, C. W.—Geological Relations of the Southern Appalachian Bauxite Deposits. *Am. Inst. Min. Eng.*, **24**, 243–54 (1894).

Hayes, C. W.—Bauxite Deposits of Arkansas. *Mining and Metallurgy*, **24**, 328–29 (1901). (Abs. *Min. Ind.*, **11** (1903).)

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, 516–8 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893*, 612 (1894).

Mead, W. J.—Occurrence and Origin of the Bauxite Deposits of Arkansas. *Econ. Geol.*, **10**, 28–54 (1915).

Parker, E. W.—Arkansas Bauxite Deposits. *Mines and Minerals*, **22**, 327–28 (1900).

Purdue, A. H.—Possibilities of the Clay Industry of Arkansas. *Ark. Brickmakers Assoc.* (1910).

Ries, H. and Bayley, W. S.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708**, 120–21, 255–9.

Siebenthal, C. E.—The Geology of Dallas County, Arkansas. Ark. Geol. Surv., *Ann. Rept., Pt. 2, 1891*, 279–318 (1894).

Simonds, F. W. and Hopkins, T. C.—The Geology of Benton County. Geol. Surv. of Ark., *Annual Rept., Vol. II, 1891*, p. 63 (1894).

Taff, J. A.—Chalks of Southwestern Arkansas. (Clays and Shales, pp. 737–40.) U. S. Geol. Surv., *22nd Annual Report, Pt. III, 1902.*

Wysor, D. C.—Aluminum Hydrates in the Arkansas Bauxite Deposits. *Econ. Geol.*, **9**, 42–50 (1916).

Wysor, D. C.—Diaspore Clay of Arkansas and Missouri. *Jour. Amer. Ceram. Soc.*, **6**, 501–9 (1923).

California

Anon.—The Clay Bed of Central California. *The Clay Worker*, **79**, 667 (1923).

Anon.—The Structural and Industrial Materials of California. Calif. State Mining Bureau, *Bull.* **38**, 190–259, 273–5 (1906).

Aubury, L. E.—The Structural and Industrial Materials of California. Calif. State Min. Bur., *Bull.* **38**, 13–378 (1906).

Boalich, E. S. and Others.—The Clay Industry in California. California State Min. Bur., *Prelim. Rept.*, No. **7**, pp. 108 (1920).

Burchfiel, B. M.—Refractory Clays of the Alberhill, California, Deposits. *Jour. Amer. Ceram. Soc.*, **6**, 1167–75 (1923).

Chatard, T. M.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228**, 370 (1904).

Chatard, T. M.—Analyses of Two Clays from Shore of Owen's Lake, Calif. U. S. Geol. Surv., *Bull.* **55**, 89 (1889).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148**, 285, 286, 301 (1897).

Crawford, J. J.—Structural Materials: Clay, Bricks, Pottery, etc. *13th Rept. Cal. State Mineralogist*, pp. 612–20 (1896).

Eckel, E. C.—Cement Materials and

Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 121 (1913).

Fisher, H.—Fullers' Earth. *Min. Ind.,* **11,** 241–2 (1903).

Hanks, H. G.—Clay. *Fourth Annual Rept. Calif. State Minerologist,* pp. 139–47 (1884).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* pp. 526–8 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893,* pp. 613, 614 (1894).

Irelan, W., Jr.—Clay in Amador County. *Eighth Ann. Report Calif. State Mineralogist,* pp. 108, 109 (1888).

Johnston, W. D.—Clays. *9th Ann. Rept. Calif. State Mineralogist,* pp. 287–308 (1890).

Koenig, G. H.—Bentonite. *Sixth Ann. Rept. Calif. State Mineralogist* [1], 132 (1886).

Normile.—China Clay in California. *Brick,* **62,** 979 (1923).

Ries, H.—The Clay-Working Industry of the Pacific Coast. *Mines and Minerals,* **20,** 487–8 (1900).

Ries, H.—The Clay-Working Industry in 1896. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (cont.), 1896–97,* p. 1130 (1897).

Ries, H., Bayley, W. S. and Others.—High-grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708,** p. 126.

Russell, J. C.—Quaternary History of Mono Valley, Calif. Analyses of Lacustral Clays, p. 307. U. S. Geol. Surv., *8th Ann. Rept., Pt. I, 1886–87,* pp. 261–394 (1889).

Watts, W. L.—Coal and Clays in Amador County. *11th Ann. Rept. Calif. State Mineralogist,* pp. 146–9 (1893).

Watts, W. L.—Placer County Clay Analyses. *11th Ann. Rept. Calif. State Mineralogist,* pp. 319–22 (1893).

Colorado

Anon.—Fullers' Earth. *Min. Ind.,* **6,** 254 (1897).

Anon.—Fullers' Earth. *Min. Ind.,* **9,** 296–8 (1900).

Bailar, J. C.—The Nonmetallic Minerals of Colorado. Colo. School of Mines, *Bien. Rept.,* pp. 46–54 (1908), pp. 35–40 (1910).

Butler, G. M.—Clays of Eastern Colorado. Colo. Geol. Surv., *Bull.* **8** (1915).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 284, 297–9 (1897).

Cross, W. and Hillebrand, W. F.—Mineralogy of the Rocky Mountains. U. S. Geol. Surv., *Bull.* **20,** 97 (1885).

Darton, N. H.—Preliminary Report of the Geology and Underground Resources of the Central Great Plains. (Fire Clay from Golden, Colo., in the analyses, p. 397.) U. S. Geol. Surv., *Prof. Paper* **32** (1905).

Day, D. T.—Fullers' Earth. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (cont.),* pp. 1353–54 (1897).

Eakin, L. G.—Kaolin from the Waterfall Mine, Gunnison County, Colo. U. S. Geol. Surv., *Bull.* **60,** 136 (1890).

Eldridge, Geo. H.—The Clays of the Denver Basin (with Analyses of Fire Clays). U. S. Geol. Surv., *Monograph* **27,** 387–92 (1896).

Fenneman, N. M.—Geology of Boulder District, Colo. U. S. Geol. Surv., *Bull.* **265,** 72 (1905).

Fisher, H.—Fullers' Earth. *Min. Ind.,* **11,** 241–2 (1903).

Geijsbeek, S.—The Colorado Clay Deposits. *The Clayworker,* **36,** 424–6 (1901).

Geijsbeek, S.—Whiteware Possibilities of Colorado Raw Materials. *Trans. Amer. Ceram. Soc.,* **7,** 98 (1906).

Hill, R. T.—Clay Materials of the United States U. S. Geol. Surv., *Mineral, Resources of the U. S., 1891,* p. 524 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1892,* p. 737 (1893).

Hillebrand, W. T.—Analyses of Rocks,

1880 to 1903. U. S. Geol. Surv., *Bull.* **228,** 366 (1904).

Hills, R. C.—Kaolinite from Red Mountain, Colorado. *Am. Jour. Sci.,* 3rd Ser., **27,** 472 (1884).

Lakes, A.—The Undeveloped Resources of Colorado. *Stone,* **14** (4), 359, 362–3 (1897).

Lakes, A.—Gypsum and Clay in Colorado. *Mines and Minerals,* **20,** Dec. (1899).

Larsen, E. S. and Wherry, E. T.—Halloysite from Colorado. *Jour. Wash. Acad. Sci.,* **7,** 178 (1917).

Larsen, E. S. and Wherry, E. T.—Leverrierite from Colorado. *Jour. Wash. Acad. Sci.,* **7,** 208–17 (1917).

Milch, L.—Über den Kaolinit von der National Belle Mine bei Silverton, Colorado. *Centralbl. f. Min.,* 1908.

Ohly, J.—The Occurrence of Bauxite in Colorado and Wyoming, and Its Utilization (1st Part). *Min. Reporter,* Sept. 12 (1901).

Reusch, H.—Krystallisirter Kaolin von Denver in Colorado. *Neues Jahrb. f. Min. Geol. u. Pal.,* **2,** 70–2 (1887). (Abs., *Bull. Soc. Min. de France,* **9,** 281–2.)

Richardson, G. B.—Clay near Calhan, El Paso County, Colo. U. S. Geol. Surv., *Bull.* **470,** 293–6 (1911).

Ries, H.—The Clay Working Industry in 1896. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (Cont.), 1896–97,* pp. 1131–8 (1897).

Ries, H.—The Clays and Clay Working Industry of Colorado. *Trans. Amer. Inst. Min. Eng.,* **27,** 336–40 (1897).

Shaler, M. K. and Gardner, J. H.—Clay Deposits of the Western Part of the Durango-Gallup Coal Field of Colorado and New Mexico. U. S. Geol. Surv., *Bull.* **315,** 296–302 (1907).

Steiger, G.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228,** 364–5 (1904).

Stokes, H. N.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228,** 366 (1904).

Connecticut

Day, D. T.—The Occurrence of Fullers' Earth in the United States. *Jour. Franklin Inst.,* **150,** 214–23(1900). (Abs. in *Rev. Amer. Chem. Research,* **7,** 67–8.)

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 502 (1892).

Ledoux, A. R.—A Novel Method of Mining Kaolin. *Trans. Amer. Inst. Min. Eng.,* **37,** 319 (1907).

Loughlin, G. F. The Clays and Clay Industries of Connecticut. Conn. Geol. and Nat. Hist. Surv., *Bull.* **13** [4], 121 pp. (1905). (Abs., *Geol. Centralb.,* **8,** 34 (1906).)

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 78 (1903).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708,** 99 (1921).

District of Columbia

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 504 (1892).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 80–1 (1903).

Delaware

Booth, J. C.—Kaolin. *Memoir of the Geological Survey of the State of Delaware,* pp. 36, 37 (1841).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 288 (1897).

Hill, R. T.—Clay Materials of the United

States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 503, (1892).

Matson, G. C.—Notes on the Clays of Delaware. U. S. Geol. Surv., *Bull.* **530,** 185–201 (1913).

Merrill, G. P.—Residual Clay of Feldspathic Rock. Kaolin, from Hockessin, Newcastle Co., Del. U. S. Geol. Surv., *Bull.* **150,** 382–4 (1898).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 80 (1903).

Steiger, G.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228,** 352 (1904).

Thomas, C. H.—Mining Kaolin in Delaware. *Min. Eng. Jour.-Press.*, **115,** 933 (1923).

Florida

Anon.—Clays in Florida. *The Clay-worker*, **51,** 707 (1909).

Anon.—Fullers' Earth. *Min. Ind.*, **6,** 254 (1897).

Anon.—Fullers' Earth. *Min. Ind.*, **9,** 296–98 (1900).

Bleininger, A. V.—Kaolins and Pottery Clays in the United States. *Brick and Clay Record*, **60,** 39–42 (1922).

Bussy, Ch. de.—Comité consultatif d'hygiéne publique de France. Vol. VI (1877). "Argile comestible" de Floride, dans les Annales des Mines, Ser. 7, **13,** p. 363.

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 290, 291 (1897).

Crary, J. W., Sr.—Brickmaking and Burning, pp. 3, 14, 35 (1890).

Davis, N. B.—The Plasticity of Clay and Its Relation to Mode of Origin. *Trans. Amer. Inst. Min. Eng.*, **51,** 451–81 (1916).

Day, D. T.—Fullers' Earth. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (cont.)*, pp. 1356–9 (1897).

Day, D. T.—Fullers' Earth. U. S. Geol. Surv., *19th Ann. Rept., Pt. VI (cont.)*, pp. 655, 656 (1898).

Eakins, L. G.—Analyses of Florida Clays. U. S. Geol. Surv., *Bull.* **228,** 355 (1904).

Fisher, H.—Fullers' Earth. *Min. Ind.*, **11,** 241–2 (1903).

Gunter, H.—Mineral Production in Florida during 1918. Fla. Geol. Survey, *13th Ann. Rept.*, p. 25 (1921).

Gunter, H.—Mineral Production in Florida during 1920. Fla. Geol. Survey, *14th Ann. Rept.*, p. 26 (1922).

Hall, A. A.—Analysis of a Florida Clay. *Durham Univ. Phil. Soc.*, **4,** 228–9 (1912).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources for 1891*, p. 507 (1893).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893*, pp. 614, 615 (1894).

Langenbeck, K.—The Chemistry of Pottery, pp. 99–101 (1895).

Matson, G. C.—Notes on the Clays of Florida. U. S. Geol. Survey, *Bull.* **380,** 346–57 (1909). (Abs., *Geol. Centralb.*, **14,** 131 (1910).)

Memminger, C. G.—Florida Kaolin Deposits. *Eng. Min. Jour.*, **57,** 436 (1894).

Meteyard, E.—Life of Josiah Wedgwood. Vol. I, p. 471 (1865).

Ries, H.—The Clays of Florida. U. S. Geol. Surv., *17th Annual Rept., Part III (cont.)*, p. 871 (1898).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 81–6 (1903).

Ries, H.—The Occurrence of High-Grade American Clays and the Possibilities of Their Further Development. *Jour. Amer. Ceram. Soc.*, **1,** 446 (1918).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays in the Eastern United States. U. S. Geol. Surv., *Bull.* **708,** 289–91 (1922).

Ries, H. and Leighton, H.—History of the Clay Working Industry in the United States, pp. 78–9 (1909).

Sellards, E. H.—Mineral Industries. Fla. Geol. Surv., *1st Ann. Rept.*, pp. 31–7 (1908).

Sellards, E. H.—Fullers' Earth, Kaolin and Peat in Florida. *Eng. Min. Jour.*, **85,** 1187 (1908).

Sellards, E. H.—Mineral Industries. Fla. Geol. Surv., *2nd Ann. Rept.*, p. 242 (1909).

Sellards, E. H.—The Soils of Florida. Fla. Geol. Surv., *4th Ann. Rept.*, p. 21 (1911).

Sellards, E. H.—The Florida Phosphate Deposits. Fla. Geol. Survey, *3rd Annual Rept.*, p. 22 (1910).

Sellards, E. H.—The Relation between the Dunnellon Formation and the Alachua Clays of Florida. Fla. Geol. Survey, *6th Ann. Rept.*, p. 161 (1914).

Sellards, E. H.—Clay and Clay Products. Fla. Geol. Surv., *6th Ann. Rept.*, p. 23 (1914).

Sellards, E. H.—Mineral Industries of Florida during 1915. Fla. Geol. Survey, *8th Ann. Rept.*, p. 19 (1916).

Sellards, E. H.—Mining Industries of Florida during 1916. Fla. Geol. Surv., *9th Ann. Report*, p. 10 (1917).

Sellards, E. H.—Geology between the Ocklocknee and Aucilla Rivers in Florida. Fla. Geol. Surv., *9th Annual Rept.*, pp. 111–2 (1917).

Sellards, E. H. and Gunter, H.—Geology between the Choctawhatchee and Appalachicola Rivers in Florida. Fla. Geol. Surv., *11th Ann. Rept.*, p. 83 (1918).

Sellards, E. H.—Report on Clay Tests for Paving Brick. Fla. State Geol. Surv., *Press. Bull.* No. **7** (1915).

Sellards, E. H.—The Clays of Florida. *Jour. Amer. Ceram. Soc.*, **1,** 313–21 (1918).

Stokes, H. N.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228,** 356 (1904).

Vaughan, T. W.—Fullers' Earth of Southwestern Georgia and Western Florida. U. S. Geol. Surv., *Mineral Resources for 1901*, pp. 922–34 (1902). (Abs., *Geol. Centralb.*, **4,** 144 (1904).)

Vaughan, T. W.—Fullers' Earth Deposits of Florida and Georgia. U. S. Geol. Surv., *Bull.* **213,** 392–9 (1903). (Abs., *Geol. Centralb.*, **4,** 144 (1904).)

Watkins, J. H.—White-Burning Clays of the Southern Appalachian States. *Trans. Amer. Inst. Min. Eng.*, **51,** 481–501 (1916).

Williams, J. L.—A View of West Florida. p. 69 (1827).

Williams, J. L.—Territory of Florida, p. 114 (1837).

Georgia

Anon.—Clays of Central Georgia. *The Clayworker*, **47,** 917 (1907).

Anon.—Clays. *Eng. and Min. Jour.*, p. 1037 (1912).

Anon.—Fullers' Earth. *Min. Ind.*, **6,** 254 (1897).

Anon.—Georgia Kaolins to be Studied. *Chem. and Met. Eng.*, **24,** 1120 (1921).

Bleininger, A. V.—Kaolins and Pottery Clays in the United States. *Brick and Clay Rec.*, **60,** 39–42 (1922).

Bole, G. A. and Stull, R. T.—Washing Tests of Georgia Clays. *Jour. Amer. Ceram. Soc.*, **6,** 730–47 (1923).

Bole, G. A. and Stull, R. T.—Use of Sedimentary Kaolins of Georgia in Whiteware. *Jour. Amer. Ceram. Soc.*, **6,** 854–64 (1923).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 282 (1897).

Day, D. T.—Fullers' Earth. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (cont.)*, p. 1359 (1897).

Day, D. T.—The Occurrence of Fullers' Earth in the United States. *Franklin Inst. Jour.*, **150,** 214–23 (1900). (Abs. in *Rev. Amer. Chem. Research*, **7,** 67–8.)

Evans, A. W.—Bauxite Mining in Georgia. *Mines and Minerals*, June (1902).

Fisher, H.—Fullers' Earth. *Min. Ind.*, **9,** 241–2 (1903).

Gilmore, R. B. and Fessler, A. H.—An account of an Investigation of Some Georgia Clays and Bauxites.

Jour. Amer. Ceram. Soc., **5**, *Bull.* **1**, 193–202 (1922).

Hayes, C. W.—Bauxite. U. S. Geol. Surv., *Mineral Resources, 1893*, pp. 159–67 (1894).

Hayes, C. W.—Bauxite. U. S. Geol. Surv., *16th Ann. Rept., 1894–95, Pt. III*, p. 551 (1895).

Hayes, C. W.—Geological Relations of the Southern Appalachian Bauxite Deposits. *Amer. Inst. Min. Eng.*, **24**, 243–54 (1894).

Hayes, C. W.—Clays. U. S. Geol. Surv., *Atlas Folio*, **19**, 3 (1895).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1892*, p. 734 (1893).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893*, pp. 615, 616 (1894).

Judd, E. K.—The Bauxite Industry of the South. *Eng. Min. Jour.*, **83**, 574–75 (1907).

Ladd, G. E.—Notes on the Cretaceous and Associated Clays of Middle Georgia. *Amer. Geol.*, **23**, 240–9 (1890).

Ladd, G. E.—Preliminary Report on a Part of the Clays of Georgia. Geol. Surv. of Ga., *Bull.* **6-A** (1898).

Maynard, T. P.—Kaolins and China Clay Resources of Alabama and Georgia along Central of Ga. Railway. Issued by Industrial Dept. Central of Ga. Railway (no date).

Maynard, T. P.—A Report on the Limestones and Cement Materials of North Georgia. Ga. Geol. Surv *Bull.* **27** (1912).

McCallie, S. W.—Bauxite Deposits of Southern Georgia. *Eng. Min. Jour.*, **91**, 1050 (1911).

McCallie, S. W.—A Preliminary Report on the Mineral Resources of Georgia. Ga. Geol. Surv., *Bull.* **24**, 37 pp. (1910).

Nichols, E.—An Aluminum Ore, Analysis of Bauxite from Floyd County, Ga. *Trans Amer. Inst. Min. Eng.* **16**, 905. (Abs. *Jour. Iron and Steel Institute* **2**, 228–9 (1888).)

Phalen, W. C.—The Bauxite Industry in the Southern States (Abs.). *Science*, New Ser., **39**, 400–1 (1914).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, 86–93 (1903).

Ries, H.—The Occurrence of High-Grade American Clays and the Possibilities of Their Further Development. *Jour. Amer. Ceram. Soc.*, **1** [7], 446–67 (1918).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708**, 82, 194–9, 224–5, 233–5, 239 (1921).

Shearer, H. K.—A Report on the Bauxite and Fullers' Earth of the Coastal Plain of Georgia. Ga. Geol. Surv., *Bull.* **31** (1917).

Spencer, J. W.—The Paleozoic Group. Clays. Ga. Geol. Surv., p. 276 (1893).

Sproat, I. E.—Refining and Utilization of Georgia Kaolins. U. S. Bureau of Mines, *Bull.* **128** (1916).

Steiger, G.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228**, 356 (1904).

Stokes, H. N.—Analysis of Kaolin from Georgia Side of Savannah River, near Augusta. U. S. Geol. Surv., *Bull.* **78**, 120 (1891).

Stull, R. T.—Directory of Commercial Minerals in Georgia and Alabama along the Central of Georgia Railway. Issued by Industrial Department of Central of Georgia Railway (no date).

Stull, R. T. and Bole, G. A.—Refractory Possibilities of Some Georgia Clays. *Jour. Amer. Ceram. Soc.*, **6**, 663 (1923).

Vaughan, T. W.—Fullers' Earth Deposits of Florida and Georgia. U. S. Geol. Surv., *Bull.* **213**, 392–9 (1903). (Abs., *Geol. Centralb.*, **4**, 144 (1904).)

Vaughan, T. W.—Fullers' Earth of Southwestern Georgia and Western Florida. U. S. Geol. Surv., *Mineral Resources, 1901*, pp. 922–34 (1902). (Abs., *Geol. Centralb.*, **4**, 144 (1904).)

Veatch, O.—Second Report on the Clay Deposits of Georgia. Ga. Geol. Surv., *Bull.* **18,** 453 pp. (1909).

Veatch, O.—Fire Clays of Central Georgia. U. S. Geol. Surv., *Bull.* **315,** pp. 304–14 (1907). (Abs. in *Jour. Iron and Steel Inst.,* **75,** 342 (1907).)

Veatch, O.—Kaolin Mining in Georgia. *Eng. Min. Jour.,* **83,** 278 (1907).

Veatch, O.—The Kaolins of the Dry Branch Region, Georgia. *Econ. Geol.,* **3,** 109–17 (1908). (Abs., *Geol. Centralb.,* **12,** 87 (1909).)

Watkins, J. H.—Occurrence of Bauxite in Central Georgia. *Min. World,* **62,** 1073–5 (1915).

Watkins, J. H.—White-Burning Clays of the Southern Appalachian States. *Trans. Am. Inst. Min. Eng.,* **51,** 489, 498 (1916).

Watson, T. L.—The Georgia Bauxite Deposits; Their Chemical Constitution and Genesis. *Amer. Geol.,* **27,** 25–45 (1901). (Analyses reproduced in Groth's *Zeit. f. Krystallag. u. Min.,* **37,** 79 (1903).) (Abs., *Neues Jahrb. f. Min.,* **2,** 17 (1904). Referata.)

Watson, T. L.—A Preliminary Report on the Bauxite Deposits of Georgia. Ga. Geol. Surv., *Bull.* **11,** 169 pp. (1904).

Watson, T. L.—A Preliminary Report on the Bauxite Deposits of Georgia. Bibliography, pp. 159–69. Geol. Surv. Ga., *Bull.* **2,** 169 pp. (1904).

Idaho

Bullard, S. M.—Geology and Ore Deposits of Alturas Quadrangle. Idaho Bur. Mines and Geol., *Bull.* No. **5.**

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 526 (1892).

Skeels, F. H.—A Preliminary Report on the Clays of Idaho. Idaho Bur. Mines and Geol., *Bull.* **2,** 74 (1920).

Soper, E. K.—Fire Clays in Northern Idaho. *Jour. Amer. Ceram. Soc.,* **1,** 94–8 (1918).

Wilson, H., Bennett, A. L. and Heath, F. T.—Preliminary Report on the Residual Kaolin and Feldspar in the Pacific Northwest. *Jour. Amer. Ceram. Soc.,* **6,** 475–90 (1923).

Illinois

Alden, W. C.—U. S. Geol Surv., Geol., Atlas, *Chicago Folio,* **81,** 13 (1902).

Barrett, N. O.—Mineral Resources of Illinois in 1916. (Bibliography of Clay, pp. 38–9.) Ill. Geol. Surv., *Bull.* **30,** p. 68 (1920).

Barrett, N. O.—Mineral Resources of Illinois in 1917 and 1918, Bibliography of Clay. Ill. Geol. Surv., *Bull.* **38,** 110–11 (1922).

Barrett, N. O.—Production of Clay. Ill. Geol. Surv., *Min. Res. Ill.,* 1917–1918, pp. 84–90.

Cady, G. H.—Geology and Mineral Resources of the Hennepin and La-Salle Quadrangles. Ill. Geol. Surv., *Bull.* **30,** 52–3, 69, 110–4 (1919).

Campbell, M. R. and Leverett, F.—U. S. Geol. Surv., Geol. Atlas, *Danville Folio,* No. 67, p. 7 (1900).

Chatard, T. M.—Analyses of Two Clays from Henry County, Ill. U. S. Geol. Surv., *Bull.* **27,** 66–7 (1886).

Chatard, T. M.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228,** 359 (1904).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 293 (1897).

Culver, H. E.—The Geology and Mineral Resources of the Morris Quadrangles. Ill. Geol. Surv., *Bull.* **43,** 148–9, 194–7 (1923).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** pp. 149–51 (1913).

Fuller, M. L. and Clapp, F. G.—U. S.

Geol. Surv., Geol. Atlas, *Patoka Folio,* No. **105,** p. 9 (1904).

Fuller, M. L. and Clapp, F. G.—Clays in the Patoka Quadrangle. *The Clayworker,* **41,** 706 (1904).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 510 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1892,* p. 735 (1893).

Hinds, H.—U. S. Geol. Surv., Geol. Atlas, *Colchester-Macomb Folio,* No. **208,** pp. 9–11 (1919).

Lines, E. F.—Pennsylvanian Fire Clays of Illinois. Ill. State Geol. Surv., *Bull.* **30,** pp. 61–73 (1917).

Parmelee, C. W.—Refractory Clays of Illinois. *Jour. Amer. Ceram. Soc.,* **5,** 685 (1922). (Abs., *Jour. Iron and Steel Inst.,* **106,** 266 (1922).)

Parmelee, C. W. and Shroyer, C. R.—Further Investigations of Illinois Fire Clays. Ill. Geol. Surv., *Bull.* **38,** 273–417 (1922).

Purdy, R. C. and DeWolf, F. W.—Results of a Preliminary Investigation of Illinois Fire Clays. Ill. Geol. Surv., *Bull.* No. **4,** 129–75. (Abs. in *Jour. Iron and Steel Inst.,* **76,** [1], 251 (1908).)

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 94–6 (1903).

Ries, H.—The Occurrence of High-Grade American Clays and the Possibilities of Their Further Development. *Jour. Amer. Ceram. Soc.,* **1** [7], 446–67 (1918).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708,** 236, 284–9.

Rolfe, C. W.—Geology of Clays. Ill. Geol. Surv., *Bull.* **9,** 1–35 (1908).

Rolfe, C. W., Talbot, A. N., Purdy, R. C. and Baker, I. O.—Paving Brick Clays of Illinois. Ill. State Geol. Surv., *Bull.* **9** (1908).

Savage, T. E. and Udden, J. A.—The Geology and Mineral Resources of the Edgington and Milan Quadrangles. Ill. Geol. Surv., *Bull.* **38,** 197–8 (1922).

Savage, T. E.—Geology and Mineral Resources of the Avon and Canton Quadrangles. Ill. Geol. Surv., *Bull.* **38,** 262–3 (1922).

Savage, T. E. and Nebel, M. L.—The Geology and Mineral Resources of the LaHarpe and Good Hope Quadrangles. Ill. Geol. Surv., *Bull.* **43,** 72–5 (1923).

Shaw, E. W.—Clay Resources of the Murphysboro Quadrangle, Ill. U. S. Geol. Surv., *Bull.* **470,** 297–301 (1911).

Shaw, E. W. and Savage, T. E.—U. S. Geol. Surv., Geol. Atlas, *Murphysboro-Herrin Folio,* No. **185,** p. 15 (1912).

Shaw, E. W. and Savage, T. E.—U. S. Geol. Surv., Geol. Atlas, *Tallula-Springfield Folio,* No. **188,** p. 12 (1913).

Shaw, E. W. and Trowbridge, A. C.—U. S. Geol. Surv., Geol. Atlas, *Galena-Elizabeth Folio,* No. **200,** p. 12 (1916).

Shaw, E. W.—U. S. Geol. Surv., Geol. Atlas, *New Athens and Okawville Folio,* No. **213,** p. 11 (1921).

Shaw, E. W.—U. S. Geol. Surv., Geol. Atlas, *Carlyle–Centralia Folio,* No. **216,** p. 10 (1923).

Skewes, H. J.—Mineral Resources of Illinois in 1913 and 1914. Ill. Geol. Surv., *Bull.* **30,** 36–9 (1917).

St. Clair, S.—Clay Deposits near Mountain Glen, Union County, Illinois. Ill. State Geol. Surv., *Bull.* No. **36,** pp. 71–83 (1920).

Stull, R. T. and Hursh, R. K.—Tests on Clay Materials available in Illinois Clay Mines. Ill. Coal Mining Investigations., *Bull.* **18** (1917).

Udden, J. A.—Structural Materials in Illinois. Ill. Geol. Surv., *Bull.* **16,** 342–93 (1910).

Udden, J. A. and Shaw, E. W.—U. S. Geol. Surv., Geol. Atlas, *Belleville-Breese Folio,* No. **195,** p. 12 (1915).

Worthern, A. H.—Economic Geology of Illinois, **1,** 278, 453, 470, 496; **2,** 55, 303, 316; **3,** 235.

Indiana

Blatchley, W. S.—Clay in Indiana. *Eng. and Min. Jour.*, **73**, 205 (1902).

Blatchley, W. S.—A Preliminary Report on the Clays and Clay Industries of the Coal-Bearing Counties of Indiana. Dept. of Geol., Ind., *20th Annual Rept., 1895*, pp. 24–179 (1896).

Blatchley, W. S.—Natural Resources of Indiana. (Clays, pp. 18–20.) Geol. Surv. Ind., *21st Ann. Rept., 1896*, pp. 18–20.

Blatchley, W. S.—The Clays and Clay Industries of Northwestern Indiana. Geol. and Nat. Resources of Indiana. *22nd Ann. Rept., 1897*, pp. 105–53 (1898).

Blatchley, W. S.—The Natural Resources of Indiana. Clays and Kaolin. Geol. Surv. Ind., *24th Ann. Rept., 1900*, pp. 28–32.

Blatchley, W. S.—The Clays and Clay Industries of Indiana. Dept. Geol. and Nat. Resources, Ind., *29th Ann. Rept., 1904*, pp. 13–657 (1905).

Bucher, W. H.—Logan's Explanation of the Origin of Indiana's "Kaolin." *Econ. Geol.*, **16** [7], 481–92 (1921).

Collett, J.—Clays of Indiana. *11th Ann. Rept. State Geologist*, p. 21 (1882).

Collett, J.—Clays and Kaolins in Indiana. *12th Ann. Rept. State Geologist*, p. 24 (1883).

Collett, J.—Kaolin in Owen Co., Indiana. *7th Ann. Rept. State Geologist*, p. 358 (1876).

Cox, E. T.—Indianaite. *Geol. Rept. Indiana*, 1874, pp. 13–19. (Abs., *Amer. Jour. Sci.*, **10**, 3rd Series, p. 306; *Pop. Sci. Monthly*, **7**, 760 (1875).)

Cox, E. T.—Porcelain Tile, and Potters' Clays. Eighteen Analyses of Clays. *Geol. Rept. Indiana*, pp. 154–63 (1878).)

Fuller, M. L. and Clapp, F. G.—Clays in the Patoka Quadrangle. *The Clayworker*, **41**, 706 (1904).

Gorby, S. S.—The Clays of Miami County, Ind. *16th Ann. Rept. State Geologist, 1888*, pp. 176, 177 (1889).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 510 (1892).

Logan, W. N.—A Bio-Chemical Theory of the Origin of Indianaite. *Science*, New Ser., **49**, 197 (1919).

Logan, W. N.—Note on the Occurrence of Indianaite in Monroe Country, Indiana. *Indiana Acad. Sci. Proc.*, pp. 177–82 (1918).

Logan, W. N.—Kaolin of Indiana. Ind. State Dept. of Conservation, *Bull.* **6** (1920); also *Econ. Geol.*, **15**, 542 (1920).

Logan, W. N.—Report of the Division of Geology Ind. Dept. Conservation, *1st Ann. Rept.* (Reprinted from Year Book), pp. 9–39 (1920).

Logan, W. N.—Economic Geology of Indiana. Ind. Dept. Conservation, Handbook of Indiana Geology, No. **21**, p. 571 (1922).

Logan, W. N.—Indianaite of Indiana. U. S. Geol. Surv., *Bull.* **708**, 147–54 (1922).

Logan, W. N.—Refractory Clays and Shales of Indiana. *Jour. Amer. Ceram. Soc.*, **7**, 201–6 (1924).

Ries, H.—The Clayworking Industry in 1896. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (cont.), 1896–97*, pp. 1138, 1139 (1897).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, 98–114 (1903).

Ries, H.—The Deposits of Indianaite near Huron, Lawrence County, Ind. U. S. Geol. Surv., *Bull.* **708**, 154–62 (1921).

Thompson, M.—The Clays of Indiana. *15th Ann. Rept. of State Geologist*, pp. 34–40 (1886).

Thompson, W. H.—Indiana Kaolin. *16th Ann. Rept. of State Geologist, 1888*, pp. 77–80 (1889).

Iowa

Arey, M. F.—Brick Clay of Black Hawk County. Ia. Geol. Surv., *Ann. Rept.*, **16**, 449 (1905).

Bain, H. F.—Clays of Appanoose County. Ia. Geol. Surv., *Ann. Rept.*, **5**, 434–6 (1895).

Bain, H. F.—Clays of Carroll County. Ia, Geol. Surv., *Ann. Rept.*, **9**, 101–3 (1898).

Bain, H. F.—Clays of Decatur County. Ia. Geol. Surv., *Ann. Rept.*, **8**, 300, 301 (1897).

Bain, H. F.—Clays of Guthrie County. Ia. Geol. Surv., *Ann. Rept.*, **7**, 475–9 (1896).

Bain, H. F.—Clay Industries of Keokuk County. Ia. Geol. Surv., *Ann. Rept.*, **4**, 302–4 (1894).

Bain, H. F.—Cretaceous Deposits of Sioux Valley. Ia. Geol. Surv., *Ann. Rept.*, **3**, 101–14 (1893).

Bain, H. F.—Clay Industries of Mahaska County. Ia. Geol. Surv., *Ann. Rept.*, **4**, 368–72 (1894).

Bain, H. F.—Clays of Washington County. Ia. Geol. Surv., *Ann. Rept.*, **5**, 163–6 (1895).

Bain, H. F.—Clays of Woodbury County. Ia. Geol. Surv., *Ann. Rept.*, **5**, 288–95 (1895).

Bain, H. F.—Clays of Polk County. Ia. Geol. Surv., *Ann. Rept.*, **7**, 366–405 (1896).

Bain, H. F.—Clays of Plymouth County. Ia. Geol. Surv., *Ann. Rept.*, **8**, 351–4 (1897).

Bates, C. O.—Analyses of Clays. Ia. Geol. Surv., *Ann. Rept.*, **7**, 382, 386, 389, 391 (1897).

Beecher, M. F.—An Investigation of Iowa Fire Clays. Ia. State Coll. Agric. and Mech. Arts., Eng. Expt. Sta., *Bull.* **40** (1915).

Beyer, S. W.—Clays of Boone County. Ia. Geol. Surv., *Ann. Rept.*, **5**, 222–8 (1895).

Beyer, S. W.—Clay Industries of Marshall County. Ia. Geol. Surv., *Ann. Rept.*, **7**, 252–6 (1896).

Beyer, S. W.—Clays of Story County. Ia. Geol. Surv., *Ann. Rept.*, **9**, 219–25 (1898).

Beyer, S. W.—Clays of Hardin County. Ia. Geol. Surv., *Ann. Rept.*, **10**, 291–7 (1899).

Beyer, S. W. and Young, L. E.—Geology of Monroe County, Iowa. Clays. Iowa Geol. Surv., *Ann. Rept., 1902*, **13**, 415–8 (1903).

Beyer, S. W. and Others.—Clays and Clay Industries of Iowa. Ia. Geol. Surv., *Ann. Rept.*, **14**, 35–620 (1903).

Beyer, S. W. and Williams, I. A. Technology of Clays. Analyses. Iowa 1903. Geol. Surv., *Ann. Rept.*, **14**, 29–318 (1904).

Beyer, S. W.—Analyses of Clays. Ia, Geol. Surv., *Ann. Rept.*, **17**, 79–86. 538–40 (1906).

Beyer, S. W. and Williams, I. A.—The Geology of Clays. Iowa Geol. Surv., **14**, 377–554 (1904).

Beyer, S. W., Bissell, G. W., Williams, I. A., Weems, J. B. and Marston, A.—Clays and Clay Industries of Iowa (1904). Reviewed in *Nature*, **72**, 388–9 (1905).

Bissell, G. W., Beyer, S. W., Williams, I. A., Weems, J. B. and Marston, A.—Clays and Clay Industries of Iowa (1904). Reviewed in *Nature*, **71**, 388–9 (1905).

Calvin, S.—Brick Clays of Buchanan County. Ia. Geol. Surv., *Ann. Rept.*, **8**, 250 (1897).

Calvin, S.—Brick and Tile of Page County. Ia. Geol. Surv., *Ann. Rept.*, **9**, 453, 454 (1900).

Calvin, S.—Cretaceous Deposits of Woodbury and Plymouth Counties. Ia. Geol. Surv., *Ann. Rept.*, **1**, 147–61 (1892).

Calvin, S.—Clays of Allamakee County. Ia. Geol. Surv., *3rd Ann. Rept.*, **4**, 94–6 (1894).

Calvin, S.—Clays of Jones County. Ia.

Geol. Surv., *Ann. Rept.*, **5,** 107–9, (1895).

Calvin, S.—Clays of Johnson County. Ia. Geol. Surv., *Ann. Rept.*, **7,** 101–3 (1896).

Calvin, S.—Clays of Cerro Gordo County. Ia. Geol. Surv., *Ann. Rept.*, **7,** 189–92 (1896).

Calvin, S.—Clays of Delaware County. Ia. Geol. Surv., *Ann. Rept.*, **8,** 185, 186 (1897).

Calvin, S.—Clays of Howard County. Ia. Geol. Surv., *Ann. Rept.*, **13,** 76, 77 (1902).

Calvin, S.—Clays of Chickasaw County. Ia. Geol. Surv., *Ann. Rept.*, **13,** 288 (1902).

Calvin, S.—Clays of Winneshiek County. Ia. Geol. Surv., *Ann. Rept.*, **16,** 138 (1905).

Calvin, S. and Bain, H. F.—Clays of Dubuque County. Ia. Geol. Surv., *Ann. Rept.*, **10,** 604–8 (1899).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 293 (1897).

Cook, A. N.—A New Deposit of Fullers' Earth. *Iowa Acad. Sci., Proc. for 1903,* **9,** 135–7 (1904). (Abs., *Geol. Centralb.*, **9,** 355 (1907).)

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 154, 155, 160 (1913).

Emery, R. — Analyses of Iowa Clays. Geol. Surv. Iowa, by C. A. White, *Rept.*, **2,** 349–50.

Gordon, C. H.—Clays of Van Buren County. Ia. Geol. Surv., *Ann. Rept.*, **4,** 244–7 (1894).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the United States for 1891*, p. 514 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources for 1892*, p. 735 (1893).

Keyes, C. R.—Brick and Other Clays of Des Moines. *Proc. Iowa Acad. Sci.*, 1890–91.

Keyes, C. R.—Clay Deposits of Lee Counties. Ia. Geol. Surv., *Ann. Rept.*, **3,** 389–96 (1893).

Keyes, C. R.—Clay Industries of Des Moines County. Ia. Geol. Surv., *Ann. Rept.*, **3,** 479–83 (1893).

Keyes, C. R.—Lithology of the Coal Measures. Ia. Geol. Surv., *Ann. Rept.*, **2,** 126–31 (1894).

Lees, James H.—The Clay Deposits of Iowa in General, and of Mason City in Particular. *The Clayworker,* **50,** 610–2 (1908).

Leonard, A. G.—Clays of Dallas County. Ia. Geol. Surv., *Ann. Rept.*, **8,** 101–7 (1897).

Leonard, A. G.—Clay of Wapello County. Ia. Geol. Surv., *Ann. Rept.*, **12,** 493–6 (1901).

Leonard, A. G.—Clays of Clayton County. Ia. Geol. Surv., *Ann. Rept.*, **16,** 293–6 (1905).

Lonsdale, E. H.—Clays and Their Uses. (Montgomery County.) Ia. Geol Surv., *Ann. Rept.*, **4,** 437–45 (1894).

MacBride, T. H.—Clays of Humboldt County. Ia. Geol. Surv., *Ann. Rept.*, **9,** 143 (1898).

MacBride, T. H.—Brick Clay of Osceola and Dickinson Counties. Ia. Geol. Surv., *Ann. Rept.*, **10,** 226 (1899).

MacBride, T. H.—Brick Clay of Clay and O'Brien Counties. Ia. Geol. Surv., *Ann. Rept.*, **11,** 486, 491 (1900).

MacBride, T. H.—Brick and Tile of Cherokee and Buena Vista Counties. Ia. Geol. Surv., *Ann. Rept.*, **12,** 341–2 (1901).

MacBride, T. H.—Clays of Kossuth, Hancock, and Winnebago Counties. Ia. Geol. Surv., *Ann. Rept.*, **13,** 108 (1902).

MacBride, T. H.—Clays of Emmet, Palo Alto, and Pocahontas Counties. Ia. Geol. Surv., *Ann. Rept.*, **15,** 256, 257 (1904).

MacBride, T. H.—Clays of Sac and Ida Counties. Ia. Geol. Surv., *Ann. Rept.*, **16,** 543, 544 (1905).

Marston, A., Beyer, S. W., Bissell, G. W., Williams, I. A. and Weems, J. B.—

Clays and Clay Products of Iowa (1904). Reviewed in *Nature,* **72,** 388–9 (1905).

Miller, B. L.—Clays of Marion County. Ia. Geol. Surv., *Ann. Rept.,* **11,** 189–91 (1900).

Norton, W. H.—Clays of Linn County. Ia. Geol. Surv., *Ann. Rept.,* **4,** 190–3 (1894).

Norton, W. H.—Clays of Scott County. Ia. Geol. Surv., *Ann. Rept.,* **9,** 499–503 (1898).

Norton, W. H.—Clay of Cedar County. Ia. Geol. Surv., *Ann. Rept.,* **11,** 387–8 (1900).

Norton, W. H.—Clay of Bremer County. Ia. Geol. Surv., *Ann. Rept.,* **14,** 392–3 (1905).

Ries, H.—The Clay-Working Industry in 1896. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (cont.), 1896–97,* pp. 1139, 1140 (1897).

Savage, T. E.—Clays of Benton County. Ia. Geol. Surv., *Ann. Rept.,* **15,** 221–3 (1904).

Savage, T. E.—Clay of Fayette County. Ia. Geol. Surv., *Ann. Rept.,* **15,** 537–40 (1904).

Savage, T. E.—Clay of Henry County. Ia. Geol. Surv., *Ann. Rept.,* **12,** 300, 301 (1901).

Savage, T. E.—Clays of Jackson County. Ia. Geol. Surv., *Ann. Rept.,* **16,** 646–7 (1905).

Savage, T. E.—Clays of Tama County. Ia. Geol. Surv., *Ann. Rept.,* **13,** 250–3 (1902).

Stokes, H. N.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228,** 359 (1904).

Tilton, J. L.—Clays of Warren County. Ia. Geol. Surv., *Ann. Rept.,* **5,** 356–9 (1895).

Tilton, J. L. and Bain, H. F.—Clays of Madison County. Ia. Geol. Surv., *Ann. Rept.,* **7,** 535 (1896).

Udden, J. A.—Clay of Jefferson County. Ia. Geol. Surv., *Ann. Rept.,* **12,** 432–3 (1901).

Udden, J. A.—Clay Industries of Clinton County. Ia. Geol. Surv., *Ann. Rept.,* **15,** 426–7 (1904).

Udden, J. A.—Clay Industries of Louisa County. Ia. Geol. Surv., *Ann. Rept.,* **11,** 119–20 (1900).

Udden, J. A.—Clay Industries of Mills and Fremont Counties. Ia. Geol. Surv., *Ann. Rept.,* **13,** 178–9 (1902).

Udden, J. A.—Clay Industries of Muscatine County. Ia. Geol. Surv., *Ann. Rept.,* **9,** 372–4 (1898).

Udden, J. A.—Clay Industries of Pottawattamie County. Ia. Geol. Surv., *Ann. Rept.,* **11,** 270–2 (1900).

Weems, J. B., Beyer, S. W., Bissell, G. W., Williams, I. A. and Marston, A.—Clays and Clay Industries of Iowa (1904). Reviewed in *Nature,* **72,** 388–9 (1905).

Whitford, W. G. and O. J. Whittemore.—Possibilities of Pottery Manufacture from Iowa Clays. Iowa State College of Agriculture, **19,** No. 4, *Bull.* **58.**

Wilder, F. A.—Clays of Lyon and Sioux Counties. Ia. Geol. Surv., *Ann. Rept.,* **10,** 149–51 (1899).

Wilder, F. A.—Clay of Webster County. Ia. Geol. Surv., *Ann. Rept.,* **12,** 174–9 (1901).

Williams, I. A.—Clay of Franklin County. Ia. Geol. Surv., *Ann. Rept.,* **16,** 501–3 (1905).

Williams, I. A.—Clay of Jasper County. Ia. Geol. Surv., *Ann. Rept.,* **15,** 348–54 (1904).

Youtz, L. A.—Clays of the Indianola Brick, Tile and Pottery Works (Warren Co., Iowa). *Iowa Acad. Sci. Proc.,* **3,** 40–44 (1896).

Kansas

Adams, G. I., Haworth, E. and Crane, W. R.—Clays in Iola Quadrangle. U. S. Geol. Surv., *Bull.* **238,** Econ. Geol. of the Iola Quad., pp. 70–4 (1904).

Gould, C. N.—Dakota Cretaceous of Kansas and Nebraska. *Trans. Kans. Acad. Sci.,* **17,** 150 (1901).

Grimsley, G. P.—Kansas Mineral Products.

Kans. Board of Agric., *Eleventh Bien. Rept., 1897–98*, p. 507 (1898).

Grimsley, G. P.—The Early Clay Industry of Kansas. *Trans. Kans. Acad. Sci.*, **17**, 200–7 (1901).

Hay, R.—The River Countries of Kansas: Some Notes on Their Geology and Mineral Resources. *Trans. Kans. Acad. Sci.*, **14**, 230–60 (1896).

Haworth, E.—The River Counties of Kansas. Clays. *Trans. Kans. Acad. Sci.*, **14**, 243–5, 252–3, 258 (1893–94).

Haworth, E.—Annual Bulletins on Mineral Resources of Kansas issued by Kans. Geol. Surv. as follows: 1897, p. 81; 1898, p. 61; 1899, p. 57; 1900–01, p. 60; 1902, p. 40,

Haworth, E.—Clay Beds of the Kansas Tertiary. *Kans. Univ. Geol. Surv.*, **2**, 273 (1897).

Haworth, E.—Clay, Useful Minerals of Kansas. U. S. Geol. Surv., *Bull.* **624**, 135–8 (1917).

Haworth, E. and Adams, G. I.—Brickmaking. Characteristics and Properties of Clays of the Iola quadrangle, Kans. U. S. Geol. Surv., *Bull.* **238**, 69–74 (1904).

Hay, R.—Geology and Mineral Resources of Kansas. State Agric. Board, *Eighth Bien. Rept., 1891–92*, p. 54 (1893).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 515 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1892*, pp. 731–3 (1893).

Hinds, H. and Grane, F. C.—Clay of the Leavenworth Region. Description of Leavenworth and Smithville Quadrangle. U. S. Geol. Surv., *Atlas Folio*, **206** (1917).

Prosser, C. S.—Clay Deposits of Kansas. U. S. Geol. Surv., *Mineral Resources for 1892*, pp. 731–3 (1894).

Sanford, S. and Stone, R. W.—Useful Minerals of Kansas. U. S. Geol. Surv., *Bull.* **585**, pp. 78–80 (1914).

Schrader, F. C. and Haworth, E.—Clay Industries of the Independence Quadrangle, Kansas. U. S. Geol. Surv., *Bull.* **260**, pp. 546–59 (1905). (Abs., *Geol. Centralb.*, **10**, p. 444 (1907–08).)

Teetor, P.—Clay and Shale Resources in the Vicinity of Arkansas City, Kansas. Kans. State Geol. Surv., *Bull.* **8**, 38–47 (1921).

Teetor, P.—The Clays of Eastern Kansas. *Trans. Amer. Ceram. Soc.*, **16**, 120–6 (1914).

Kentucky

Anon.—The Kaolin Deposits of Southern Kentucky. *The Clayworker*, **44**, 460 (1905).

Ashley, G. H.—Discussion of an Article by Ellis Lovejoy entitled "Notes on Fire Clays of the Northern Appalachian Coal Basin." *Jour. Amer. Ceram. Soc.*, **2**, 790–3 (1919).

Berry, E. W.—The Lower Eocene Flora of Southeastern N. America. U. S. Geol. Surv., *Prof. Paper* **91** (1916).

Butts, C.—Descriptions and Correlation of the Mississippian Formations of Western Kentucky. Ky. Geol. Surv. (1912).

Butts, C.—Geology of Jefferson County, Ky. Ky. Geol. Surv. (1914–15).

Campbell, M. R.—U. S. Geol. Surv., *Atlas Folio*, London and Richmond Quadrangles.

Clarke, F. W.—Analyses of Clays. Analyses of Rocks, 1880–1903 (Fire Clay from Carter Co., Ky.). U. S. Geol. Surv., *Bull.* **228**, 359 (1904).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148**, p. 282 (1897).

Crandall, A. R.—Report on the Geology of Greenup, Carter and Boyd Counties, Ky. Ky. Geol. Surv., Vol. **C**, Eastern Coal Field, pp. 1–78 (1884).

Crandall, A. R. and Sullivan, G. M.—The Coal Field Adjacent to Pineville Gap. Ky. Geol. Surv., *Bull.* **14**, Serial No. 17 (1912).

Crider, A. F.—Clays of Western Kentucky and Tennessee. U. S. Geol. Surv., *Bull.* **285**, pp. 417–27 (1906).

Crider, A. F.—The Fire Clays and Fire Clay Industries of the Olive Hill and Ashland Districts of Northeastern Kentucky. Ky. Geol. Surv., *4th Ser.*, **1**, 589–711 (1913).

Crump, M. H.—Clays and Building Stones in Kentucky. *Eng. and Min. Jour.*, **66**, 190 (1898).

Easton, H. D.—Report on the Technology of Kentucky Clays. Including Chemical and Mechanical Analyses, and Burning Tests. Ky. Geol. Surv., *4th Ser.*, **1** (Pt. II), 713–888 (1913).

Eckel, E. C.—Clay Resources of Northeastern Kentucky. U. S. Geol. Surv., *Bull.* **288** (1906).

Foerste, A. F.—Silurian Clays, with Notes on Clays of the Waverly and Irvine Formations of Kentucky. Ky. Geol. Surv., *Bull.* **6**, pp. 143–78 (1905).

Foerste, A. F.—The Silurian, Devonian, and Irvine Formations of East Central Ky., with an Account of Their Clays and Limestones. Ky. Geol. Surv., *Bull.* **7** (1906); also *Bull.* **6**, p. 146 (1905).

Fohs, F. J.—Clays in Crittenden and Livingston Counties, Ky. Ky. Geol. Surv., *Bull.* **6** (1905).

Galpin, S. L.—Studies of Flint Clays and Their Associates. *Trans. Amer. Ceram. Soc.*, **14**, 301–46 (1912).

Gardner, J. H.—Clays of the Red River Valley, Kentucky. Ky. Geol. Surv., *Bull.* **6**, pp. 64–79 (1905).

Gardner, J. H.—Clays and Sands of the Jackson Purchase Region. Ky. Geol. Surv., *Bull.* **6** (1905).

Gardner, J. H.—The Kaolins and Plastic Clays of the Eastern Rim of the Western Coalfield, Kentucky. Ky. Geol. Surv., *Bull.* **6** (1905).

Gardner, J. H.—Miscellaneous Analyses of Kentucky Clays and Marls. Kentucky Geol. Surv., *Bull.* **6**, pp. 179–223 (1905).

Gardner, J. H.—Preliminary Report on the Economic Geology of the Hartford Quadrangle. Ky. Geol. Surv., *Bull.* **20**, 1–25 (1912).

Glenn, L. C.—A Geological Reconnaissance of the Tradewater Region with Special Reference to the Coal Beds. Ky. Geol. Surv., *Bull.* **17**, Serial 27 (1912).

Glenn, L. C.—The Underground Waters of the Eastern United States, Tennessee and Kentucky. U. S. Geol. Surv., *Water Supply and Irrigation Paper.*, No. 164 (1906).

Greaves-Walker, A. F.—The Flint Fire Clay Deposits of Northeastern Kentucky. *Trans. Amer. Ceram. Soc.*, **9**, 461–72 (1907); *Ibid.*, **8**, 297 (1906).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 509 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1892*, p. 724 (1893).

Hutchinson, F. M.—The Geology and Coals of Central City, Madisonville, Calhoun and Newburg Quadrangles; in Muhlenberg, Hopkins, Ohio, McLean, Webster, Daviess and Henderson Counties. Ky. Geol. Surv., *Bull.* No. **19**, Serial No. 26 (1912).

Loughridge, R. H.—The Geological and Economic Features of the Jackson Purchase Region. Ky. Geol. Surv., pp. 355 (1888).

Loughridge, R. H.—Report on the Geology of Clinton County, with Map. Ky. Geol. Surv., 48 pp. (1890?).

Lovejoy, E.—Notes on Fire Clays of the Northern Appalachian Coal Basin. *Jour. Amer. Ceram. Soc.*, **2** [5], 374–90 (1919).

Miller, A. M.—Discussion on "Fire Clays of the Eastern Coalfield of Kentucky." *Jour. Amer. Cer. Soc.*, **5** [8], 161 (1922).

Miller, A. M.—The Geology of Kentucky. Dept. Geol. and Forestry, Ser. V, *Bull.* **2**, 329–34 (1919).

Peter, R.—Chemical Report of the Coals, Clays, Mineral Water, etc., of Ken-

tucky. Ky. Geol. Surv., *Bull.* No. **3** (1905).

Phalen, W. C.—Clay Resources of Northeastern Kentucky. U. S. Geol. Surv., *Bull.* **385**, 411–6 (1906).

Phalen, W. C.—Description of the Kenova Quadrangle. U. S. Geol. Surv., Geol. Atlas, *Kenova Folio,* No. **184** (1912). (Abs., *Jour. Wash. Acad. Sci.,* **3,** 455 (1913).)

Phalen, W. C. Economic Geology of the Kenova Quadrangle. U. S. Geol. Surv., *Bull.* **349** (1908).

Ries, H.—The Clay Deposits of Kentucky. Ky. Geol. Surv., Ser. 6, **8** (1922).

Ries, H.—Fire Clays of the Eastern Coal Field of Kentucky. *Jour. Amer. Ceram. Soc.,* **5** [7], 397 (1922).

Ries, H.—The Occurrence of High-Grade American Clays and the Possibilities of Their Further Development. *Jour. Amer. Ceram. Soc.,* **1** [7], 446–67 (1918).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708,** pp. 226, 236–8, 276–82 (1921).

Ries, H., and Leighton, H.—History of the Clay Working Industry in the United States (1909).

Ulrich, E. O. and Smith, W. S. T.—Lead, Zinc and Fluorspar Deposits of Western Kentucky. U. S. Geol. Surv., *Prof. Paper* **36** (1905).

Louisiana

Clendennin, W. W.—Clays of Louisiana. *Eng. and Min. Jour.,* **66,** 456–7 (1898).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 507 (1892).

Matson, G. C.—Louisiana Clays. U. S. Geol. Surv., *Bull.* **660** (1917).

Ries, H.—A Report on Louisiana Clay Samples. A Preliminary Report on the Geology of Louisana by G. D. Harris and A. C. Veatch. La. Expt. Sta., Pt. 5, pp. 263–75 (1899). (Review, *Jour. Geol.,* **11,** 548.)

Maine

Bastin, E. S.—Clays of the Penobscot Bay Region, Maine. U. S. Geol. Surv., *Bull.* **285,** 428–31 (1906).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 194 (1913).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 502 (1892).

Katz, F. J.—Clay in the Portland Region, Maine. U. S. Geol. Surv., *Bull* **530,** 202–6 (1913).

Monell, W.—The Clay Industries of Maine. *Eng. and Min. Jour.,* **66,** 161 (1898).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** p. 132 (1903).

Maryland

Ashley, G. H.—Discussion of an Article by Ellis Lovejoy entitled "Notes on Fire Clays of the Northern Appalachian Coal Basin." *Jour. Amer. Ceram. Soc.,* **2** [10], 790–93 (1919).

Clark, W. B.—Brief Account of Maryland Mineral Resources and Description of Exhibit of Maryland Mineral Products (Clays). Prepared for St. Louis Exposition, 1904. Clays, p. 3.

Clark, W. B.—Clays. Md. Geol. Surv., *The Geography of Md.,* **10,** 105, 106, 161 (1918).

Clark, W. B.—Clays, pp. 34, 214; Porcelain Materials, pp. 35, 216. Maryland Geol. Surv., **1** (1897).

Clark, W. B.—Maryland and Its Natural Resources. Official Publication of Maryland Commissioners Pan-American Exposition, Baltimore, 1901. Clays, p. 16.

Clark, W. B.—Maryland Mineral Industries, 1896–1907. Md. Geol. Surv., Vol. **8**, pp. 109–16 (1909).

Clark, W. B.—Physical Features of Maryland. Md. Geol. Surv., **1** (1897). (Clay, pp. 214–6.)

Clark, W. B.—The Relation of Maryland Topography, Climate and Geology to Highway Construction. Md. Geol. Surv., **3** (1899). (Sands and Clays, p. 104.)

Clark, W. B. and Mathews, E. B.—The Clays and Clay Products. Md. Geol. Surv., *The Physical Features of Maryland*, **6**, 191–6 (1906).

Clark, W. B. and Mathews, E. B.—Clays and Clay Products. Md. Geol. Surv., *Md. Min. Ind.*, **8**, 109–18 (1909).

Clark, W. B., O'Harra, C. C., Rowe, R. B, and Ries, H.—The Mineral Resources of Allegany County, Md. (Clays). Md. Geol. Surv., Allegany County, pp. 180–5, 194 (1900).

Dorsey, C. W.—Soil Formations. Md. Geol. Surv., *Rept. on Allegany County*, pp. 200–13 (1900).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522**, pp. 199 (1913).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 504 (1892).

Kennicutt, L. P. and Rogers, J. F.—Fire Clays from Mt. Savage, Allegany County, Md. *Jour. Anal. and App. Chem.*, **5**, 101, 542–4 (1891). (Abs., *Jour. Iron and Steel Inst.*, **1**, 306 (1892).)

Little, H. P.—The Clays. Md. Geol. Surv., *Rept. on Anne Arundel County* pp. 119–22 (1917).

Lovejoy, E.—Notes on Fire Clays of the Northern Appalachian Coal Basin. *Jour. Amer. Ceram. Soc.*, **2** [5], 374–90 (1919).

Martin, G. C.—Clays. Md. Geol. Surv., *Rept. on Garrett Co.*, pp. 212–20 (1902).

Mathews, E. B.—The Mineral Resources of Cecil County. Md. Geol. Surv., *Rept. on Cecil County*, pp. 204–17 (1902).

Mathews, E. B. and Grasty, J. S.—Clays. Md. Geol. Surv., **8**, *Rept. on the Limestones of Maryland*, pp. 297–9, 347, 348 (1909).

Mathews, E. B., Watts, A. S., Schurecht, H. G., Swartz, C. K. and Hall, G. M.—The Fire Clays of Maryland. Md. Geol. Surv., **11**, pp. 291–539 (1922).

Miller, B. L.—Economic Resources of Calvert Co. Md. Geol. Surv., *Rept. on Calvert Co.*, pp. 123–34 (1907).

Miller, B. L.—Economic Resources of St. Marys County. Md. Geol. Surv., *Rept. on St. Marys County*, pp. 113–24 (1907).

Miller, B. L.—Prince Georges County—Physiography, Geology and Mineral Resources. Md. Geol. Surv., *Rept. on Prince Georges County*, pp. 24–150 (1911).

O'Harra, C. C.—Clays. Md. Geol. Surv., *Rept. on Allegany County*, pp. 87, 130 (1900).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, pp. 134–48 (1903).

Ries, H.—Report on the Clays of Maryland. Md. Geol. Surv., **4**, pp. 203–505 (1902).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708**, pp. 18, 201, 204 (1921).

Singewald, J. T., Jr.—Analysis of Blue Clay. Md. Geol. Surv., *Rept. on the Iron Ores of Md. with an Account of the Iron Industry*, **9**, pp. 196, 236, 237.

Steiger, G.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228**, 353 (1904).

Massachusetts

Anon.—Clays and Clayworking in Massachusetts. *The Clayworker*, **58**, 173 (1912).

Alden, W. C.—Fullers' Earth and Brick Clays near Clinton, Mass. U. S. Geol. Surv., *Bull.* **430**, 402–4 (1910).

Brown, R. M.—The Clays of the Boston Basin. *Amer. Jour. Sci.*, **14**, 4th Ser., 445–50 (1902).

Clarke, F. W.—Analysis of Clays. U. S. Geol. Surv., *Bull.* **228**, Analyses of Rocks, 1880–1903; (from Mass.) p. 351 (1904).

Clarke, F. W.—Analyses of Eight Clays, etc., from Martha's Vineyard, Mass. U. S. Geol. Surv., *Bull.* **55**, pp. 89–90 (1889).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148**, 287 (1897).

Crosby, W. O.—The Kaolin in Blandford, Mass. *Tech. Quarterly*, **3** [3], 228–337 (1890).

Emerson, B. K.—A Mineralogical Lexicon of Franklin, Hampshire, and Hampden Counties, Mass. U. S. Geol. Surv., *Bull.* **126**, Kaolinite, pp. 97–9 (1865).

Fuller, M. L.—Clays of Cape Cod, Mass. U. S. Geol. Surv., *Bull.* **285**, 432–41 (1906).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 502 (1892).

Hitchcock, E.—Final Report on the Geology of Mass. Vol. 1. Economical Geology, 1841. (Clay in the manufacture of alum, fire brick, etc., 215; glazing for porcelain, p. 221; Clay for Brick, pp. 183–84), also *Amer. Jour. Sci.*, **22**, 37 (1832).

Hitchcock, E.—Report on the Geology, Mineralogy, Botany and Zoölogy of Massachusetts, 1883. (Porcelain Clay, p. 36; Potter's Clay, p. 37; Clays, p. 38.)

Hollis, F. S.—Kaolin in Ashland, Mass. Technology Quarterly, **5**, 108–13 (1892).

Ries, H.—Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, 149–53 (1903).

Sears, J. H.—The Physical Geography, Geology, Mineralogy and Paleontology of Essex County, Massachusetts (1905). Clays, p. 357.

Shaler, N. S.—The Brickmaking Clays of Massachusetts. U. S. Geol. Surv., *16th Ann. Rept., 1894–95, Pt. II*, pp. 324–6 (1895).

Shaler, N. S., Woodworth, J. B. and Marbut, C. F.—The Glacial Brick Clays of Rhode Island and Southeastern Massachusetts. U. S. Geol. Surv., *17th Ann. Rept.* [*Pt. I*], pp. 951–1004 (1896).

Whittle, Chas. L.—The Clays and Clay Industry of Massachusetts. *Eng. and Min. Jour.*, **66**, 245–6 (1898).

Whittle, Chas. L.—The Clay Industry of Massachusetts. *Min. Ind., 1898*, **7**, 125–8 (1899).

Michigan

Anon.—Mineral Resources of Michigan. Mich. Geol. and Biol. Surv., No. **32**, pp. 61–9.

Brown, G. G.—The Clays and Shales of Michigan and Their Uses. Mich. Geol. Surv., *Pub.* **36**, Geol. Ser. 30.

Cooper, W. F.—Geological Report on Bay County. Mich. Geol. Surv., *Rept. for 1905*, pp. 389–94 (1906).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522**, 216–22 (1913).

Fall, D.—Marls and Clays of Michigan. Mich. Geol. Surv., **8** [Pt. 3], pp. 343–53 (1903); *Mich. Eng.*, p. 124–33 (1901); *Mich. Miner*, **3** [11], pp. 11–14 (1901).

Gordon, C. H.—Geological Report on

Sanilac County. Mich. Geol. Surv., **7** [3], 23, 25 (1900).

Grabau, A. W.—Stratigraphy of the Traverse Group of Michigan. *Rept. Geol. Surv. Mich. for 1901*, pp. 163, 188, 189, 192, 195 (1902).)

Hale, D. J. and Others.—Report on Marl (Bog Lime). Mich. Geol. Surv., **8** [3] (1903). Short notes and analyses on many pages, especially p. 345.

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 522 (1892).

Lane, A. C.—Geological Report on Huron County. Mich. Geol. Surv., **7** [2], 208–11 (1900).

Lane, A. C.—The Clays of Alcona County, Mich. Geol. Surv. of Mich., 1901, pp. 61–3 (1902).

Lane, A. C.—Michigan Clays, Shales and Paving Materials. *The Gateway*, pp. 49–51, Jan. (1904). (Abs., *Geol. Centralb.*, **5**, p. 254 (1904).)

Lane, A. C.—Report of State Board of Geological Survey of Michigan 1903. Analyses of clays. Pp. 184–8 (1905).

Lane, A. C.—*Sixth Annual Report of State Geologist for 1904*, p. 120 (1905).

Lane, A. C.—List of Localities and Mills Manufacturing Portland Cement. Occurrence and Analysis of Clays. Mich. Geol. Surv., **8** [Pt. 3], pp. 224–342 (1903).

Lane, A. C.—*Eighth Annual Report of State Geologist for 1906*, p. 587 (1907).

Ries, H.—Clays and Shales of Michigan Geol. Surv., Mich., **8** [Pt. I], 1900.

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, 153–9 (1903).

Ries, H.—The Shales of Michigan. *Stone*, **21**, 20–24 (1900).

Russell, J. C.—A Geological Reconnaissance along the North Shores of Lakes Huron and Michigan. *Rept. State Board of Geol. Surv. of Mich., 1904*, pp. 93–4 (1905).

Sherzer, W. H.—Geological Report on Monroe County. Mich. Geol. Surv., **7** [1], p. 188 (1900).

Sherzer, W. H.—Geology of Wayne County. Mich. Geol. and Biol. Surv., *Publication* **12**, pp. 265–9 (1911).

Smith, R. A.—Mineral Resources of Michigan. Mich. Geol. and Biol. Surv., *Pub.* **19**, Geol. Ser., 16, pp. 302–8 (1915).

Minnesota

Berkey, Charles P.—Origin and Distribution of Minnesota Clays. *Amer. Geol.*, **29**, 171–7 (1902). (Abs., *Geol. Centralb.*, **5**, 254 (1904).)

Chatard, T. M.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228**, 359 (1904).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148**, 293 (1897).

Grout, F. F.—The Clays of Minnesota. *Jour. Geog.*, **14**, 185–87 (1916).

Grout, F. F.—Clays and Shales of Minnesota. U. S. Geol. Surv., *Bull.* **678**, 259 pp. (1919). (Abs. by R. W. Stone, *Jour. Wash. Acad. Sci.*, **9** [19], 600 (1919).)

Grout, F. F. and Soper, E. K.—Preliminary Report on the Clays and Shales of Minnesota. Geol. and Nat. Hist. Surv. of Minn., *Bull.* **11**, 1914. (Issued also as U. S. Geol. Surv., *Bull.* **678.**)

Winchell, N. H.—The Geology of Minnesota. The Geological and Natural History Survey of Minnesota, *Final Report*, **1** (1872–1882), **2** (1882–1885), **4** (1896–1898).

Winchell, N. H.—Preliminary Report On the Building Stones, Clays, Limes, Cements, Roofing, Flagging and Paving Stones of Minnesota. Minn. Geol. Surv., *Ann. Rept.*, **8**, 60–69 (1880).

Mississippi

Anon.—Clay and Cement in Mississippi. *Eng. and Min. Jour.*, **82,** 1062 (1906).

Bledsoe, O. F.—The Clays of Mississippi. *The Clayworker*, **40,** 277–8 (1903).

Burchard, E. F.—Bauxite Associated with Siderite. Geol. Soc. Amer., *Bull.* **25,** 437–8 (1924).

Burchard, E. F.—Bauxite in Northeastern Mississippi. U. S. Geol. Surv., *Bull.* **750,** 101–46 (1925).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 292 (1897).

Crider, A. F.—Clays of Mississippi. Miss. Geol. Surv., *First Biennial Report* (1908).

Crider, A. F.—The Geology and Mineral Resources of Mississippi. U. S. Geol. Surv., *Bull.* **283.** (Abs. in *The Clayworker*, **46,** 497 (1906).)

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 244 (1913).

Eckel, E. C.—Stoneware and Brick Clays of Western Tennessee and Northwestern Mississippi. U. S. Geol. Surv., *Bull.* **213,** 382–91 (1903).

Emmons, S. F. and Hayes, C. W.—Contributions to Economic Geology. U. S. Geol. Surv., *Bull.* **260,** 515 (1905).

Hilgard, E. W.—Report on the Geology of Mississippi, p. 244 (1844).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S. for 1891*, p. 508 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893*, p. 616 (1894).

Hutchinson, W. L.—Analyses of Clays from Mississippi. Miss. Agricultural and Mech. College, Exper. Sta., *8th Ann. Rept.*, p. 105 (1895).

Logan, W. N.—Brick Clays and Clay Industry of Northern Mississippi. Miss. Geol. Surv., *Bull.* **2** (Pt. I).

Logan, W. N.—Clays of Mississippi, Pt. 2. Brick Clays and Clay Industry of Southern Mississippi. Miss. State Geol. Surv., *Bull.* **4,** 72 pp. (1904). (Abs., *Geol. Centralb.*, **13,** 363 (1909–10).)

Logan, W. N.—The Pottery Clays of Mississippi. Miss. Geol. Surv., *Bull.* **6** (1914). (Abs. in *Min. and Eng. Mag.*, **90,** 369 (1910).)

Logan, W. N. and Hand, W. F.—A Preliminary Report on Some of the Clays of Mississippi. Miss. Geol. Surv., *Bull.* **3** (Miss. Agricultural and Mech. Coll., *Bull.* **2** [3], 88 (1905).)

Lowe, E. N.—Clays. Miss. Geol. Surv., *3rd Biennial Report* (1911).

Lowe, E. N.—Clays. Miss. Geol. Surv., *5th Biennial Report* (1915).

Lowe, E. N.—Clays. Miss. Geol. Surv., *7th Biennial Report* (1919).

Lowe, E. N.—Clays. Miss. Geol. Surv., *8th Biennial Report* (1921).

Lowe, E. N.—Mississippi: Its Geology, Geography, Soils and Mineral Resources. Miss. Geol. Surv., *Bull.* **12** (1915).

Lowe, E. N.—Mississippi: Its Geology, Geography, Soils and Mineral Resources. Miss. Geol. Surv., *Bull.* **14** (1919).

Lowe, E. N.—Mineral Resources of Mississippi. *Manufacturers Record*, Dec. 11 (1924).

Lowe, E. N.—A Questionnaire on the Mineral Resources of Mississippi, and the Work of the State Geological Survey. Miss. Geol. Surv., *Bull.* **18** (1923).

Morse, P. F.—The Bauxite Deposits of Mississippi. Miss. Geol. Surv., *Bull.* **19** (1922).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 159–61 (1903).

Ries, H., Bayley W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708,** 206–11, 235–6, 239–55 (1921).

Ries, H.—The Occurrence of High-Grade American Clays and the Possibilities of Their Further Development. *Jour. Amer. Ceram. Soc.*, **1** [7], 446–67 (1918).

E. C. Sullivan.—Stoneware Clay from Holly Springs, Miss. Analyses of Clays. Analyses of Rocks, 1880–1903. U. S. Geol. Surv., *Bull.* **228,** 357 (1904).

Missouri

Broadhead, G. C.—Adair County (Mo.). *Rept. Geol. Surv. Missouri, 1873–74,* p. 255 (1874).

Buckley, E. R.—Public Roads, Their Improvement and Maintenance. Mo. Bur. Geol. and Mines, *2nd Series,* **5,** 124 pp. (1907).

Buckley, E. R., Smith, A. F. and Ball, S. H.—Geology of Miller County. Mo. Bur. Geol. and Mines, *2nd Series,* **1,** 207 pp. (1913).

Buehler, H. A.—The Lime and Cement Resources of Missouri. Mo. Bur. Geol. and Mines, *2nd Series,* **6,** 255 pp. (1907).

Buehler, H. A.—Mo. Bur. Geol. and Mines, *Biennial Report of the State Geologist to the 45th General Assembly,* 59 pp. (1909).

Buehler, H. A.—Mo. Bur. Geol. and Mines *Biennial Report of the State Geologist to the 47th General Assembly,* 54 pp. (1913).

Buehler, H. A.—Mo. Bur. Geol. and Mines, *Biennial Report of the State Geologist to the 48th General Assembly,* 62 pp. (1915).

Buehler, H. A.—Mo. Bur. Geol. and Mines, *Biennial Report of the State Geologist to the 49th General Assembly,* 75 pp. (1917).

Buehler, H. A.—Mo. Bur. Geol. and Mines, *Biennial Report of the State Geologist to the 50th General Assembly,* 117 pp. (1919).

Buehler, H. A.—Mo. Bur. Geol. and Mines, *Biennial Report of the State Geologist to the 51st General Assembly,* 87 pp. (1921).

Buehler, H. A.—Mo. Bur. Geol. and Mines, *Biennial Report of the State Geologist to the 52nd General Assembly,* 133 pp. (1923).

Buehler, H. A.—Mo. Bur. Geol. and Mines, *Biennial Report of the State Geologist to the 53rd General Assembly,* (1925).

Chatard, T. M.—Analyses of "Tallow Clays." U. S. Geol. Surv., *Bull.* **90,** 64 (1892).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 295, 296 (1897).

Dake, C. L.—The Sand and Gravel Resources of Missouri. Mo. Bur. Geol. and Mines, *2nd Series,* **15,** 250 pp. (1918).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 248–49 (1913).

Fenneman, N. M.—Clay Resources of the St. Louis District, Mo. U. S. Geol. Surv., *Bull.* **315,** 315–21 (1907).

Fenneman, N. M.—Geology and Mineral Resources of the St. Louis Quadrangle, Missouri-Illinois. U. S. Geol. Surv., *Bull.* **438** (1911).

Galpin, S. L.—Studies of Flint Clays and Their Associates. *Trans. Amer. Ceram. Soc.,* **14,** 301–46 (1912).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S. for 1891,* p. 511 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources for 1893,* p. 616 (1894).

Hinds, H.—The Coal Deposits of Missouri. Mo. Bur. Geol. and Mines, *2nd Series,* **11,** 503 pp. (1912).

Hinds, H. and Greene, F. C.—Leavenworth and Smithville Quadrangles. U. S. Geol. Surv., *Geologic Folio,* **206.**

Hinds, H. and Greene, F. C.—The Stratigraphy of the Pennsylvania Series in

Missouri. Mo. Bur. Geol. and Mines, *2nd Series*, **13**, 500 pp. (1915).

Keyes, C. R.—Distribution and Character of Missouri Clays. *Min. Ind.*, **5**, 127–37 (1897).

Keyes, C. R.—Geological Occurrence of Clays. Missouri Geol. Surv., **11**, 35–48 (1896).

Keyes, C. R., Winslow, A., Gordon, C. H., Haworth, E. and Nason, F. L.—Reports on Areal Geology (sheets 1 and 2). Mo. Bur. Geol. and Mines, *1st Series*, **9**, 430 pp. (1896).

Ladd, G. E.—The Clay, Stone, Lime and Sand Industries of St. Louis, Mo., City and County. Geol. Surv. Mo., *Bull.* **3**, 5–37 (1890).

Ladd, G. E.—Notes on Certain Undescribed Clay Occurrences in Missouri. *Science* (New Series), **3**, 691–3 (1896).

Ladd, G. E.—Notes on the Clays and Building Stones of Certain Western Central Counties Tributary to Kansas City. Geol. Surv. Mo., *Bull.* **5** (1891).

Lee, W.—The Geology of the Rolla Quadrangle. Mo. Bur. Geol. and Mines, *2nd Series*, **12** (1913).

Marbut, C. F.—Clay Deposits of the Huntsville Quadrangle. Mo. Geol. Surv., **12**, 362–5 (1898).

Marbut, C. F.—Geology of Lexington Sheet. Geol. Surv. of Missouri, **12**, [Pt. 2], 243–5 (1898).

Marbut, C. F.—The Geology of Morgan County. Mo. Bur. Geol. and Mines, *2nd Series*, **7**, 97 pp. (1906).

Marbut, C. F.—Geology of Richmond Quadrangle. Mo. Geol. Surv. **12**, [Pt. 2], 299–302 (1898).

McCourt, W. E., Albertson, M. and Bennett, J. W.—The Geology of Jackson County. Mo. Bur. Geol. and Mines, *2nd Series*, **14**, 158 pp. (1917).

Mühlhäuser, O.—Der Thon von St. Louis. *Z. f. angewandte Chemie*, pp. 148–59(1903). (Abs., *Geol. Centralb.*, **5**, 253 (1904).)

Orton, E., Jr.—The Kaolin Deposits of Bollinger County, Missouri. *Trans. Amer. Ceram. Soc.*, **9**, 62–94 (1907).

Ries, H.—The Clay Working Industry in 1896. U. S. Geol. Surv., *18th Ann. Rept. 1896–97* [*Pt. V*] (*cont.*), p. 1140–3 (1897).

Ries, H.—Occurrence of Glass-Pot Clays in the U. S. *Mineral Resources of the U. S. for 1901* (1902).

Ries, H.—The Occurrence of High-Grade American Clays and the Possibilities of Their Further Development. *Jour. Amer. Ceram. Soc.*, **1** [7], 446–67 (1918).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708**, 135–47, 104–8 (1921).

Rowley, R. R.—The Geology of Pike County. Mo. Bur. Geol. and Mines, 2nd Series, **8**, 122 pp. (1908).

Schmidt, A. and Leonhard, A.—The Lead and Zinc Regions of Southwest Missouri. Rept. Geol. Surv. Missouri, 1873–74, pp. 407–9, 515–6 (1874).

Seamon, W. H.—Zinciferous Clays of Southwest Missouri. *Amer. Jour. Sci.*, Jan., p. 38 (1890); *Sci. Amer. Supp.*, **30**, 122–87 (1890).

Shepard, E. M.—A Report on Greene County (Mo.). Geol. Surv. of Mo., **12** [Pt. 1], 212–20 (1898).

Shepard, E. M., Marbut, C. F. and Broadhead, G. C.—Areal Geology. Mo. Bur. Geol. and Mines, 1st Series, **12**, Sheets 5–10, 656 pp. (1898).

Stokes, H. N.—Analyses of Rocks 1880 to 1903. U. S. Geol. Surv., *Bull.* **228**, 362 (1904).

Thornberry, M. H.—A Treatise on Missouri Clays. Issued by School of Mines and Metallurgy, Rolla, Mo. (1925).

Van Horn, R. B.—The Geology of Moniteau County. Mo. Bur. Geol. and Mines, *2nd Series*, **3**, 104 pp. (1905).

Wheeler, H. A.—Clay Deposits. Mo. Bur. Geol. and Mines, *1st Series*, **11**, 622 pp. (1896).

Wheeler, H. A.—Clay Deposits of the Clinton Sheet. Geol. Surv. of Mo., **12** (Pt. 2), 80–95 (1898). Clay Deposits of the Calhoun Sheet, pp. 176–83. Clay Deposits of the Huntsville Quadrangle pp. 362–5, 367–8.

Wheeler, H. A.—Clay Resources of Missouri. *Eng. and Min. Jour.*, **66**, 426–7 (1898).

Wheeler, H. A.—Clays and Shales on the Bevier Sheet. Report on the Bevier Sheet. Missouri Geol. Surv., **9**, 57–67 (1896).

Wheeler, H. A.—The Fire Clays of Missouri. Bi-monthly, *Bull. Amer. Inst. Min. Eng.*, No. **1**, 103–16 (1905). (Also *Trans. Amer. Inst. Min. Eng.*, **35**, 720–34 (1905).)

Winslow, A.—Lead and Zinc Deposits. Mo. Geol. Surv., **7**, 444–5 (1894).

Winslow, A.—Report on Higginsville Sheet. Mo. Geol. Surv., **9**, 93–5 (1896).

Woolford, F.—Clays of Washington County, Mo. *Western Jour.* (St. Louis), **1**, 168–9, 193–5 (1848).

Wysor, D. C.—Diaspore Clay of Arkansas and Missouri. *Jour. Amer. Ceram. Soc.*, **6**, 501–9 (1923).

Montana

Bauer, C. M.—Clay in Northeastern Montana. U. S. Geol. Surv., *Bull.* **540**, 369–72 (1914).

Fisher, C. A.—Clays in the Kootenai Formation near Belt, Montana. U. S. Geol. Surv., *Bull.* **340**, 417–23 (1908).

Hice, R. R.—The Working of Some Montana Clays. *Trans. Amer. Ceram. Soc.*, **14**, 602–14 (1912).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S. for 1891*, p. 524 (1892).

Rowe, J. P.—Economic Geology of Montana. Mont. Univ., *Bull.* **50** (Geol. Surv., No. 3), 70 pp. (1908).

Nebraska

Anon.—Fullers' Earth. *Min. Ind.*, **6**, 254 (1897).

Barbour, E. H.—Report of the State Geologist, **1**, p. 202 (1903).

Barbour, E. H.—An Important Undeveloped Clay Bed. Neb. Geol. Surv., **4** [Pt. 6], *Bull.* **28.**

Barbour, E. H.—Preliminary Report on the Clay Industry of Nebraska. Neb. Geol. Surv., **4**, 441–93 (Separate, no date).

Day, D. T.—Fullers' Earth. U. S. Geol. Surv., *18th Ann. Rept. Pt. V (cont.)*, p. 1353 (1897).

Day, D. T.—Fullers' Earth. U. S. Geol. Surv., *19th Ann. Rept. Pt. VI (cont.)*, pp. 655–56 (1898).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522**, 257 (1913).

Fisher, C. A.—Comparative Value of Bluff and Valley Wash Deposits as Brick Material. Neb. State Board of Agric., *Ann. Rept. for 1900*, pp. 181–4.

Gould, C. N. and Fisher, C. A.—The Dakota and Carboniferous Clays of Nebraska. Neb. State Board of Agriculture, *Ann. Rept.*, pp. 185–94 (1900).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S. for 1891*, p. 515 (1892).

Nevada

Barus, Carl.—Kaolinization in Geology of the Comstock Lode and the Washoe District. U. S. Geol. Surv., *Monograph*, **3**, pp. 290–308 (1882).

Buwalda, J. P.—Clays. U. S. Geol.Surv., *Bull.* **708**, 121–6 (1921).

Chatard, T. M.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228,** 369 (1904).

Chatard, T. M.—Analyses of Two Clays from Humboldt, River Bridge, Mill City, Nevada. U. S. Geol. Surv., *Bull.* **9,** 15 (1884).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 300 (1897).

Cox, P. E. and Moulton, D. A.—A New Raw Material for Ceramic Uses. *Jour. Amer. Ceram. Soc.,* **6,** 937–9 (1923).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708,** 121–6 (1921).

Russell, I. C.—Subaerial Deposits of North America. *Geol. Mag.,* **6,** 289, 342 (1889). (Adobe.)

New Hampshire

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S. for 1891,* p. 502 (1892).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 132 (1903).

New Jersey

Bascom, F.—Description of the Philadelphia District. U. S. Geol. Surv., Geol. Atlas, *Philadelphia Folio* (No. 162) (1909).

Burton.—The Clays of New Jersey. *The Clayworker,* **40,** 442–4 (1903).

Clark, W. B., Bagg, R. M., Shattuck, G. B.—Report upon the Upper Cretaceous Formations. N. J. Geol. Surv., *Ann. Rept., 1897,* p. 207 (1898).

Cook, G. H.—*Second Annual Report of the Geological Survey of the State of New Jersey for the Year 1855,* pp. 68–74, 100–2 (1856).

Cook, G. H.—*Third Annual Report on the Geological Survey of State of New Jersey for 1856,* p. 67 (1857).

Cook, G. H.—*Annual Report of the State Geologist (N. J.) for 1869.* (Fire and Potter's Clays, pp. 56, 57.)

Cook, G. H.—*Annual Report of the State Geologist (N. J.) for 1873.* (Pp. 103–4.)

Cook, G. H.—*Annual Report of the State Geologist (N. J.) for 1874.* (Clays for Pottery and Fire Bricks, pp. 42–54.)

Cook, G. H.—*Annual Report of the State Geologist (N. J.) for 1878.* (Miscellaneous Clay Deposits, pp. 48–69.)

Cook, G. H.—*Annual Report of the State Geologist (N. J.) for 1879.* Pp. 168–72.

Cook, G. H.—*Annual Report of the State Geologist (N. J.) for 1880.* (Fire Clays, Refractoriness, Tests, and Classification, pp. 131–52; Statistics, pp. 181–3.)

Cook, G. H.—*Annual Report of the State Geologist (N. J.) for 1881.* (Clays, Brick and Pottery, p. 69; Statistics, pp. 77–8.)

Cook, G. H.—*Annual Report of the State Geologist (N. J.) for 1882.* (Plastic Clays and Their Uses, pp. 74–80; Statistics, pp. 172–3.)

Cook, G. H.—Clay Deposits of New Jersey. N. J. Geol. Surv., 1878.

Cook, G. H.—Clays for Pottery and Fire Brick. N. J. Geol. Surv., *Ann. Rept.,* pp. 42–6, 116 (1874).

Cook, G. H.—Cretaceous Clays. N. J. Geol. Surv., *Ann. Rept.,* p. 242, 249–56 (1868).

Cook, G. H.—Geology of New Jersey. Newark, 1868. (Clays, pp. 683–9; Brick and Tile Materials, pp. 528–31.)

Cook, G. H.—Plastic Clays, and Their Uses. N. J. Geol. Surv., *Ann. Rept.,* p. 74–83 (1882).

Darton, N. H., Bayley, W. S., Salisbury, R. D. and Kümmel, H. B.—De-

scription of the Passaic Quadrangle N. J.–N. Y. U. S. Geol. Surv., Geol. Atlas, *Passaic Folio* (No. 157) (1908).

Day, D. T.—The Occurrence of Fullers' Earth in the United States. *Jour. Franklin Inst.*, **150** [9], 214–23 (1900). (Abs. in *Rev. Amer. Chem. Research*, **7**, 67–8.)

Dunlop, A.—On the Jersey Brick Clay. *Quart. Jour. Geol. Soc.*, London, **45**, 118 (1889).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522**, 239 (1913).

Ferry, C.—New Jersey Clays: Their Classification and Adaptability to the Manufacture of Fire Brick. *Iron Age*, **55**, 332–3 (1895).

Ferry, C.—New Jersey Fire Clays. *Iron Age*, **57**, 698 (Mar. 19) (1896).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 503 (1892).

Hollick, C. A.—The Cretaceous Clay Marl Exposure at Cliffwood, N. J. *Amer. Geol.* **18**, p. 230 (1896); *Science*, New series, **4**, 386 (1896); *Trans. N. Y. Acad. Sci.*, **16**, 124–36 (1897).

Hunt, T. S.—On the Origin of Clays on the Atlantic Seaboard. *Trans. Amer. Inst. Min. Eng.*, **6**, p. 188 (1879).

Jenkins, G. E.—Fire Brick and Clay Industry. N. J. Geol. Surv., *Ann. Rept., 1898*, pp. 195–237 (1899).

Knapp, G. N.—The Cliffwood Clays and the Matawan. *Amer. Geol.*, **33**, 23–27 (1904).

Kümmel, H. B.—Administrative Report. N. J. Geol. Surv., *Ann. Rept.*, p. 8 (1902).

Kümmel, H. B. and Knapp, G. N.—The Stratigraphy of the New Jersey Clays. N. J. Geol. Surv., *Final Rept.*, **6**, 117–209 (1904).

Newberry, J. S.—On the Raritan Clays of New Jersey. *Proc. Amer. Assoc. Adv. Sci.*, 1869.

Ries, H.—The Clays and Clay Industry of New Jersey. *Final Rept. of State Geologist*, **6** (1904).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, 161–70 (1903).

Ries, H.—Note on the Tensile Strength of Raw Clays. *Trans. Amer. Ceram. Soc.*, **6**, 79 (1923). (Abst. in *Jour. Iron and Steel Inst.*, **67** [1], 560 (1905).)

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of Eastern United States. U. S. Geol. Surv., *Bull.* **708**, 202–4 (1921).

Rogers, H. D.—Description of the Geology of the State of N. J. Potter's Clay Formation. *Final Rept.*, pp. 179–86 (1840).

Rogers, H. D.—Description of the Geology of the State of N. J. *Final Rept.*, pp. 131–8 (1865).

Rogers, H. D.—Geology of the Counties of Middlesex, Monmouth, Burlington, Gloucester, Salem, Cumberland and Cape May. N. J. Geol. Surv., *Ann. Rept.*, p. 17–25 (1836).

Rogers, H. D.—Geology of the "Marl Tract," Embracing Portions of Middlesex, Monmouth, Burlington, Gloucester and Salem Counties. N. J. Geol. Surv., *Ann. Rept.*, p. 26 (1836).

Sharkey, S. M.—The Clays of Mercer County, New Jersey. *N. J. Ceramist*, **1** [2], 131–6 (1921).

Smock, J. C.—Clay and Brick Industry of New Jersey. *Ann. Rept. of State Geologist of New Jersey for Year 1897*, pp. 324–50, 355–7.

Smock, J. C.—Fire Clays and Associated Plastic Clays, Kaolins, Feldspars and Fire Sands of New Jersey. *Trans. Amer. Inst. Min. Eng.*, **6**, 177 (1877–78); *Eng. and Min. Jour.*, **25**, 185–200 (1878).

Smock, J. C.—Mining Clay of New Jersey. *Trans. Amer. Inst. Min. Eng.*, **3**, 211 (1874–75).

Smock, J. C.—Two Hundred Clays of New Jersey. *Eng. and Min. Jour.*, New York, March, 23, 1878; March 16, p. 185 (1878).

Twitchell, W. W.—The Geology of the Clay Deposits with Particular Reference to Those of New Jersey. *The Ceramist* **4,** 211–28 (1924).

New Mexico

Blake, W. P.—Alunogen and Bauxite of New Mexico. *Trans. Am. Inst. Min. Eng.,* **24,** 571–3 (1894). (Abs. in *Am. Geologist,* **14,** p. 196.)

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 299 (1897).

Day, D. T.—Fullers' Earth. U. S. Geol. Surv., *18th Ann. Rept. Pt. V* (*cont.*), p. 1354 (1897).

Foster, W.—A Remarkable Carbonaceous Deposit Near Putnam, New Mexico. *Econ. Geol.,* **8** 360–8 (1913). (Abs. *Inst. Cong. Applied Chem.,* **8** [25], 667 (1913).)

Hayes, C. W.—Bauxite. U. S. Geol. Surv., *16th Ann. Rept. 1894–95, Pt. III,* pp. 549, 550 (1895).

Herrick, C. L.—Miscellaneous Economic Papers. New Mex. Univ., *Bull.* **2** (1900).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 525 (1892).

Russell, I. C.—Subaerial Deposits of North America. *Geol. Mag.,* **6,** 289, 342 (1889). (Adobe.)

Shaler, M. K. and Gardner, J. H.—Clay Deposits of the Western Part of the Durango-Gallup Coal Field of Colorado and New Mex. U. S. Geol. Surv., *Bull.* **315,** 296–302 (1907).

New York

Anon.—Fullers' Earth. *Min. Ind.,* **6,** 254 (1897).

Catlett, C.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228,** 352 (1904).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** p. 280–1, 288 (1897).

Day, D. T.—Fullers' Earth. U. S. Geol. Surv., *18th Ann. Rept. Pt. V* (*cont.*), p. 1354 (1897).

Day, D. T.—The Occurrence of Fullers' Earth in the United States. *Jour. Franklin Inst.,* **150** [9], 214–23 (1900). (Abs. *Rev. Amer. Chem. Research,* **7,** 67–8.)

Dwight, W. B.—A Peculiar Feature of the Clay Beds on the Western Bank of the Hudson, Three Miles North of Newburgh. *Trans. Vassar Bros. Inst.,* 1884–5.

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 287–8, 294–5 (1913).

Fairchild, H. L.—Geology of Thousand Islands Region. N. Y. State Museum (Clay Plains), *Bull.* **145,** 156–9 (1910).

Fisher, H.—Fullers' Earth. *Min. Ind.,* **11,** 241–2.

Hollick, C. A.—On Clay Beds on Staten Island. Nat. Sci. Assoc. Staten Island, *Proc.* **2,** 63 (1890).

Hollick, A.—Minerals from Fire Clay Beds at Green Ridge, Staten Island. *Amer. Nat.,* **35,** 403 (1891).

Hollick, C. A.—Notes on Staten Island Clays. Nat. Sci. Assoc. Staten Island, *Proc.* **3,** 26–7 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources for 1892,* pp. 724, 733, 734 (1893).

Hopkins, T. C.—Geology of the Syracuse Quadrangle. N. Y. State Museum (Clay), *Bull.* **171,** 34–7 (1914).

Jones, C. C.—A Geologic and Economic Survey of the Clay Deposits of the Lower Hudson River Valley. *Trans.*

Amer. Inst. Min. Eng., **29,** 40–83 (1900).

Lincoln, D. F.—Report on the Structural and Economic Geology of Seneca County, N. Y. *48th Ann. Rept., N. Y. State Museum, 1894,* **2,** pp. 105–11 (1895). Also in *14th Ann. Rept. State Geologist, 1894,* pp. 105–11 (1895).

Martin, D. S.—A Note on the Colored Clays Recently Exposed at Morrisania, N. Y. *N. Y. Acad. Sci. Trans.,* **9,** 46 (1898).

Mather, W. W.—Geology of New York. Clays. *Geol. of First District, Pt. I,* pp. 141–45, 250–56, 578 (1843).

Merrill, F. J. H.—Note on the Colored Clays at Morrisania, N. Y. *N. Y. Acad. Sci. Trans.,* **9,** 45 (1898).

Merrill, F. J. H.—Origin of the White and Variegated Clays of the North Shore of Long Island, N. Y. *N. Y. Acad. Sci. Trans.,* **12,** 113 (1900).

Merrill, F. J. H.—Clay, Shale, Kaolin, etc. Mineral Resources of N. Y. State. N. Y. State Museum, *Bull.* **3** [15], 494–518 (1895). (Also issued as part of *Museum Rept.,* **45** [1], 363 (1894).)

Nason, F. L.—The Economic Geology of Albany County. Gravels, Sands and Clays. New York State Museum. *47th Ann. Rept. for 1893,* pp. 460–8, 478 (1894).

Nason, F. L.—Economic Geology of Ulster County. Brick Manufacture. New York State Museum, *47th Ann. Rept. for 1893,* pp. 385–87 (1894).

Newland, D. H.—Mineral Resources of the State of New York. N. Y. State Mus., *Bull.* 223–4 (1921). Clay Materials, pp. 47–50.

Ries, H.—Clay Industries of New York. N. Y. State Museum, *Bull.* **3** [12] (1895). (Also part of *State Museum Rept.*)

Ries, H.—The Clay-Working Industry in 1896. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (cont.), 1896–97,* p. 1144 (1897).

Ries, H.—The Clays of the Hudson River Valley. *Trans. N. Y. Acad. Sci.,* **2,** 33–9 (1891).

Ries, H.—Clays of New York: Their Properties and Uses. N. Y. State Museum, *Bull.* **5** [35], 489–944 (1900). (A Revised and Enlarged Edition of Author's Rept. of 1895. Forms part also of 54th Ann. Rept. of Regents, Univ. of State of N. Y., Vol. II (1902).) (Review by J. F. Kemp, *Science* **13,** 946–7 (1901) and in *Jour. Geol.,* **10,** 546.)

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 170–9 (1903).

Ries, H.—Notes on the Clays of New York State and Their Economic Value. *Trans. N. Y. Acad. Sci.,* **12,** 40–7 (1892).

Ries, H.—On the Occurrence of Cretaceous Clays at Northport, Long Island. *School of Mines Quarterly,* **15,** 354–5 (1894).

Ries, H.—Physical tests of the Devonian Shales of New York State to Determine Their Value for the Manufacture of Clay Products. *15th Ann. Rept. State Geologist for 1895,* vol. 1, pp. 675–98.

Ries, H.—Physical Tests of New York Shales. *School of Mines Quarterly,* **19,** 192–4 (1898).

Ries, H.—Quaternary Deposits of the Hudson River Valley between Croton and Albany with Notes on the Brick Clays and the Manufacture of Brick. *N. Y. Geol. Rept. No. 10 for 1890,* pp. 110–55 (1891).

Stoller, J. H.—Glacial Geology of the Cohoes Quadrangle. (Clays.) N. Y. State Museum, *Bull.* **215, 216,** pp. 18, 30–2, 33–5 (1920).

Woodworth, J. B.—Ancient Water Levels of the Champlain and Hudson Valleys. N. Y. State Museum, *Bull.* **84** (1905).

Woodworth, J. B.—Pleistocene Geology of the Mooers Quadrangle. N. Y. State Museum, *Bull.* **83,** 48, 53 (1905).

North Carolina

Bain, H. F.—Review of Clay Deposits and Clay Industry in North Carolina, by H. Ries. *Jour. Geol.*, **6**, 545–7 (1898).

Bayley, W. S.—Kaolin in North Carolina, with a Brief Note on Hydromica. *Econ. Geology*, **15**, 236 (1920).

Bayley, W. S.—The Kaolins of North Carolina. N. Car. Geol. Surv., *Bull.* **29.**

Campbell, M. R. and Kimball, K. K.—The Deep River Coal Field of North Carolina. N. Car. Geol. Surv., *Bull.* **33.**

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 189 (1897).

Day, D. T.—The Occurrence of Fullers' Earth in the United States. *Jour. Franklin Inst.*, **150** [9], 214–23 (1900). (Abs. in *Rev. Amer. Chem. Research*, **7**, 67–8.)

Drane, B. S. and Stuckey, J. L.—The Mineral Industry in North Carolina from 1918–23. N. Car. Geol. Surv., *Economic Paper*, **55.**

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 505 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 505 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources for 1892*, p. 734 (1893).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893*, pp. 616, 617 (1894).

Holmes, J. A.—Notes on the Kaolin and Clay Deposits of North Carolina, *Jour. Elisha Mitchell Soc.*, 12th Year, Pt. 2, pp. 1–10 (1895).

Holmes, J. A.—Notes on the Kaolin and Clay Deposits of North Carolina. *Trans. Am. Inst. Min. Eng.*, **25**, pp. 929–36 (1896). (Abs. *Tech. Quarterly*, **9**, p. 59.)

Holmes, J. A.—Kaolin and Clay of North Carolina. *North Carolina and Its Resources*, pp. 106–7 (1896).

Kerr, W. C. Kaolin, Fire Clay, Etc. Geology of North Carolina, **1**, pp. 296–7 (1875).

Phillips, W. B.—North Carolina Fire Clays. *Eng. and Min. Jour.*, **42**, 326 (1886). (Abs. in *Dingler's Polytech. Jour.*, **263**, p. 110.)

Pratt, J. H.—The Mining Industry of North Carolina During 1900. N. Car. Geol. Surv., *Economic Paper*, **4.**

Pratt, J. H.—Mining Industry of North Carolina during 1902. N. Car. Geol. Surv., *Economic Paper*, **7.**

Pratt, J. H.—Mining Industry of North Carolina during 1903. N. Car. Geol. Surv., *Economic Paper*, **8.**

Pratt, J. H.—Mining Industry of North Carolina during 1904. N. Car. Geol. Surv., *Economic Paper*, **9.**

Pratt, J. H.—Mining Industry in North Carolina during 1905. N. Car. Geol. Surv., *Economic Paper*, **11.**

Pratt, J. H.—Mining Industry of North Carolina during 1906. N. Car. Geol. Surv., *Economic Paper*, **14.**

Pratt, J. H.—Mining Industry in North Carolina during 1907. N. Car. Geol. Surv., *Economic Paper*, **15.**

Pratt, J. H.—Mining Industry of North Carolina during 1908, 1909 and 1910. N. Car. Geol. Surv., *Economic Paper*, **23.**

Pratt, J. H.—Mining Industry of North Carolina during 1911–12. N. Car. Geol. Surv., *Economic Paper*, **34.**

Pratt, J. H.—The Mining Industry of North Carolina during 1913–17. N. Car. Geol. Surv., *Economic Paper*, **49.**

Ries, H.—Clay Deposits and Clay Industry in North Carolina. A Preliminary Rept., *Bull.* **13,** N. C. Geol. Surv. (1897). (Abs., *Tech. Quart.*, **11**, 130; Review by H. F. Bain, *Jour. Geol.*, **6**, 545–7.)

Ries, H.—The Clays of the United States

East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 179–90 (1903).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708,** 18–65, 75–9 (1921).

Watkins, J. H.—White Burning Clays of the Southern Appalachians. *Trans. Amer. Inst. Min. Eng.,* **51,** pp. 489, 498 (1916).

Watts, A. S.—Mining and Treatment of Feldspar and Kaolin in the Southern Appalachian Region. U. S. Bureau Mines, *Bull.* **53;** *Mineral Tech.,* **1,** 170 pp.

North Dakota

Babcock, E. J.—Clays of Economic Value (in N. Dakota). Geol. Surv. N. Dak., *First Rept.,* pp. 27–55 (1901).

Babcock, E. J.—The Coal and Clay Resources of North Dakota. N. Dak. Univ., *Quart. Jour.,* **5** [1], 52–56, Oct. (1914).

Babcock, E. J.—N. Dak. Geol. Surv., *1st Biennial Rept.,* 103 pp. (1901).

Babcock, E. J.—The Uses and Value of North Dakota Clays. N. Dak. State Geol. Surv., *4th Biennial Rept.,* pp. 191–243 (1906).

Babcock, E. J. and Clapp, C. H.—Clay and Its Properties with Special Reference to North Dakota Clays. N. Dak. State Geol. Surv., *4th Biennial Rept.,* pp. 6–91 (1906).

Babcock, E. J. and Clapp, C. H.—Economic Geology of North Dakota Clays. N. Dak. State Geol. Surv., *4th Bien. Rept.,* pp. 95–189 (1906).

Clapp, C. H.—The Clays of North Dakota. *Econ. Geol.,* **2** [6], 551–64 (1907).

Clapp, C. H., Leonard, A. G., Babcock, E. J.—Clays of North Dakota. N. Dak. Geol. Surv., *Biennial Rept.,* 324 pp. (1908).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 524 (1892).

Leonard, A. G.—Stratigraphy of North Dakota Clays. N. Dak. Geol. Surv., *4th Biennial Rept.,* pp. 63–94 (1906).

Leonard, A. G. and Others.—State Geological Survey of North Dakota, *5th Biennial Report* (1908).

Ohio

Andrews, E. R.—Clays of 2nd Geological District. Ohio Geol. Surv., *Rept. Prog. 1869,* pp. 131–2 (1870).

Andrews, E. R.—Report of Labors in the 2nd Geological District during the Year 1870. Ohio Geol. Surv., *Rept. Prog. 1870,* pp. 166, 168–9 (1871).

Ashley, G. H.—Discussion of an Article by Ellis Lovejoy Entitled "Notes on Fire Clays of the Northern Appalachian Coal Basin." *Jour. Amer. Ceramic Soc.,* **2** [10], 790–3 (1919).

Bleininger, A. V.—Manufacture of Cements. Clays. Ohio Geol. Surv., 4th Ser., *Bull.* **3,** 79–84, 223–6 (1904).

Carney, F.—The Economic Mineral Products of Ohio. Denison Univ., Sci. Lab., *Bull.* **16,** 137–81 (1910).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 283 (1897).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 303 (1913).

Tenneman, N. M.—Geology of Cincinnati and Vicinity. Clays. Ohio Geol. Surv., 4th Ser., *Bull.* **19,** pp. 178–80 (1916).

Galpin, S. L.—Studies of Flint Clays and Their Associates. *Trans. Amer. Ceram. Soc.,* **14,** 301–46 (1912).

Grimsley, G. P.—Some Recent Work on Clays. (Review of Ohio Geol. Surv. Rept. on Clays.) *Science,* **23,** 99–100 (1894).

Hice, R. R.—The Clays of the Upper Ohio and Beaver River Region. *Trans. Amer. Ceram. Soc.*, **7** [2], 1–14 (1905).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 509 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893*, p. 609 (1894).

Lovejoy, E.—The Clays of Five Mile Creek. *Ohio Min. Jour.*, Whole No. 17, pp. 34–40 (1888).

Lovejoy, E.—Notes on Fire Clays of the Northern Appalachian Coal Basin. *Jour. Amer. Ceram. Soc.*, **2** [5], 374–90 (1919).

Mather, W. W.—First Annual Report on the Geological Survey of the State of Ohio. Clays, p. 10 (1838).

Newberry, J. S.—Sketch of the Structure of the Lower Coal Measures in Northeastern Ohio. Ohio Geol. Surv., *Rept. Prog., 1870*, p. 50–1 (1871).

Newberry, J. S.—Geology of Cuyahoga County. Ohio Geol. Surv., **1** [1], pp. 174–7 (1873).

Newberry, J. S.—Geology of Summit County. Ohio Geol. Surv., **1** [1], pp. 220–1 (1873).

Newberry, J. S.—Geology of Tuscarawas County. Ohio Geol. Surv., 3 pp. 64, 66, 83 (1878).

Newberry, J. S.—Geology of Portage County. Ohio Geol. Surv., **3**, pp. 149–50 (1878).

Newberry, J. S.—Geology of Columbiana County. Ohio Geol. Surv., **3**, p. 131 (1878).

Newberry, J. S.—Geology of Jefferson County. Analyses by Wormley. Ohio Geol. Surv., **3**, p. 780 (1878).

Orton, E.—Report on Geology of Montgomery County. Ohio Geol. Surv., *Rept. Prog. 1869*, pp. 148–9 (1870).

Orton, E.—Geology of Clermont County. Ohio Geol. Surv., **1** [1], pp. 440–6 (1873).

Orton, E., Jr.—The Clay Working Industries of Ohio. Rept. Geol. Surv. Ohio, Vol. VII, Pt. 1. *Econ. Geol.*, pp. 69–254 (1893).

Orton, E., Jr.—The Clays of Ohio and the Industries Established upon Them. Rept. Geol. Surv. Ohio, **5**, 643–721 (1884).

Orton, E., Jr.—The Clays of Ohio, Their Origin, Composition and Varieties. Rept. Geol. Surv. Ohio, Vol. VII, Pt. 1. *Econ. Geol.*, pp. 45–68 (1893).

Phalen, W. C.—Economic Geology of the Kenova Quadrangle, Kentucky, Ohio and West Virginia. U. S. Geol. Surv., *Bull.* **349** (1908).

Read, M. C.—Sketches of the Geology of Geauga and Holmes Counties. Ohio Geol. Surv., *Rept. Prog. 1870*, pp. 482–3 (1871).

Read, M. C.—Geology of Hocking Valley Coal Field. Ohio Geol. Surv., **3** [1], p. 713 (1878).

Ries, H.—The Clay-Working Industry in 1896. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (cont.), 1896–97*, p. 1145 (1897).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, 190–208 (1903).

Ries, H.—Occurrence of Glass-Pot Clays in the U. S. *Mineral Resources of the U. S. for 1901* (1902).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708**, p. 133–5.

Stauffer, C. R., Hubbard, G. D. and Bownocker, J. A.—Geology of the Columbiana Quadrangle. Ohio Geol. Surv., 4th Ser., *Bull.* **14**, pp. 117–9 (1916).

Stevenson, J. J.—Geology of Carroll County. Ohio Geol. Surv., **3**, p. 198 (1878).

Stout, W.—The Flint Clay Situation in Ohio. *Jour. Amer. Ceram. Soc.*, **6**, 1153–9 (1923).

Stout, W.—Geology of Muskingum County. Geol. Surv. of Ohio, 4th Ser., *Bull.* **21** (1918).

Stout, W., Stull, R. T., McCaughey, W. J., and Demorest, D. J.—Coal Formation Clays of Ohio. Geol. Surv. of Ohio, 4th Ser., *Bull.* **26.**

Van Horn, F. R.—Clay and Shale Resources in the Vicinity of Cleveland, Ohio. *Trans. Amer. Ceram. Soc.*, **18,** 450–72 (1916).

Wheeler, B.—Clays and Coals of Muskingum County. *Ohio Min. Jour.*, Whole No. 18, pp. 52–4 (1889).

Winchell, N. H.—Geology of Seneca County. Ohio Geol. Surv., **1** [1], pp. 623–4 (1873).

Winchell, N. H.—Geology of Wood County. Ohio Geol. Surv., **2** [1], 386 (1874).

Winchell, N. H.—Geology of Hancock County. Ohio Geol. Surv., **2** [1], 366 (1874).

Wormley, T. G.—Report of Chemical Department. Analyses. Ohio Geol. Surv., *Rept. Prog., 1870,* pp. 445–7 (1871).

Oklahoma

Anon.—Fullers' Earth. *Min. Ind.*, **6,** 254 (1897).

Day, D. T.—Fullers' Earth. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (cont.)*, pp. 1354–6 (1897).

Gould, C. N.—Preliminary Report on the Mineral Resources of Okla. Okla. Geol. Surv., *Bull.* **1,** 84 pp. (1908).

Gould, C. N. and Others.—Brief Chapter on Oklahoma's Minerals. Okla. Geol. Surv., *Bull.* **6,** 33–95 (1910).

Gould, G. C. and Others.—Preliminary Report on the Structural Materials of Oklahoma. Okla. Geol. Soc., *Bull.* **5,** 182 pp. (1911).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 515 (1892).

Shannon, C. W.—Mineral Resources of Oklahoma. Okla. Geol. Surv., *Bull.* **22,** 118–21 (1914).

Snider, L. C.—Preliminary Report on the Clays and Clay Industries of Oklahoma. Okla. Geol. Surv., *Bull.* **7,** 207 pp. (1911). (Abs., *Geol. Centralb.*, **27,** 586 (1911–12).)

Oregon

Darton, N. H.—Structural Materials in Parts of Oregon and Washington. U. S. Geol. Surv., *Bull.* **387,** 33 pp. (1909).

Geijsbeek, S.—The Clay Deposits of Oregon. *Trans. Amer. Ceram. Soc.*, **15,** 644–58 (1913).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 528 (1892).

Parks, H. M.—The Economic Geological Resources of Oregon. Ore. Bur. Mines (Ore. Agricultural Coll., Coll. B, Extension Series **5,** No. 2, 120 pp. (1912)).

Stafford, O. F.—The Mineral Resources and Mineral Industry of Oregon for 1903. Ore. Univ., *Bull. Nat. Sci.*, **1** [4], 112 pp. (1904).

Pennsylvania

Anon.—Clays and Shales of Clarion County, Pennsylvania. *Eng. and Mining Jour.*, **84,** 346 (1907).

Anon.—Clay Studies in Pennsylvania. (White Clays of South Mountain by Geo. W. Stose, Clays and Shales of Clarion County by E. F. Lines.) *The Clayworker*, **48,** 249 (1907).

Anon.—Pittsburgh's Clay Production. *The British Clayworker*, **31,** 232 (1922–23).

Anon.—Fire Clay—A Study of the Clays

of Clinton County, Pa. *Mines and Minerals*, **24**, 378–9 (1904).

Ashburner, C. A.—The Geology of McKean County. Pa. Sec. Geol. Surv., *Rept.* **R**, pp. 87, 88 (1880).

Ashburner, C. A.—Report on the Brandywine Smmit Kaolin-bed, Delaware County. Pa. Geol. Surv., *Ann. Rept.*, pp. 593–614 (1885).

Ashley, G. H.—The Fire Brick Materials of Pennsylvania. *Jour. Amer. Ceram. Soc.*, **6** [7], 837–49 (1923).

Ashley, G. H.—Notes on Clays and Shales in Central Pennsylvania. U. S. Geol. Surv., *Bull.* **285**, 442–44 (1906).

Ashley, G. H.—Clay and Shale. Pa. Top. and Geol. Surv., *Rept. 1906–08*, pp. 307–25 (1908).

Ashley, G. H.—Discussion of an Article by Ellis Lovejoy, Entitled "Notes on Fire Clays of the Northern Appalachian Coal Basin." *Jour. Amer. Ceram. Soc.*, **2** [10], 790–3 (1919).

Brown, A. P. and Ehrenfeld, F.—Minerals of Pennsylvania. Pa. Top. and Geol. Surv., *Rept.* **6**, 21–39 (1913).

Butts, C.—Description of the Warren Quadrangle, Pennsylvania-New York. U. S. Geol. Surv., Geol. Atlas, *Warren Folio*, No. **172** (1910).

Butts, C.—Economic Geology of the Kittanning and Rural Valley Quadrangles, Pa. U. S. Geol. Survey, *Bull.* **279**, 198 pp. (1906).

Catlett, C.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228**, 352 (1904).

Catlett, C.—Miscellaneous Analyses. U. S. Geol. Surv., *Bull.* **64**, 51 pp.

Chance, H. M.—A Revision of the Bituminous Coal Measures of Clearfield County. Pa. Sec. Geol. Surv., Rept. **H**, pp. 167–80 (1884).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148**, 288 (1897).

D'Invilliers, E. V.—Report on the Geology of the Four Counties Union, Snyder, Mifflin and Juniata. Pa. Sec. Geol. Surv., Rept. **F3**, 123, 252 (1888–89).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522**, 316 (1913).

Frazer, P.—Report of Progress in York, Adams and Franklin Counties. Pa. Sec. Geol. Surv., Rept. **CC**, 203, 204 (1875).

Galpin, S. L.—Studies of Flint Clays and Their Associates. *Trans. Amer. Ceram. Soc.*, **14**, 301–46 (1912).

Hall, C. E.—Field Notes in Delaware County. Pa. Sec. Geol. Surv., Rept. **C5**, 47, 48, 76 (1885).

Harden, E. B.—Report on Fire Clay of Wellersburg Coal Basin, Somerset County. Pa. Geol. Surv., *Ann. Rept. 1885*, pp. 239–49 (1886).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 503 (1892).

Hice, R. R.—The Clays of the Upper Ohio and Beaver River Region. *Trans. Amer. Ceram. Soc.*, **7**, 251–62 (1905).

Hice, R. R.—The Fire Clays of Pennsylvania. *Trans. Amer. Ceram. Soc.*, **18**, 401 (1916).

Hice, R. R.—The White Clay Possibilities of Pennsylvania. *Jour. Amer. Ceram. Soc.*, **2** [9], 685–94 (1919).

Hice, R. R.—*Eng. Min. Jour.*, **88**, 105–7. (Abs. in *Jour. Iron and Steel Inst.*, **80** [2], 348 (1909).)

Hopkins, T. C.—Clay and Feldspars of Southeastern Pennsylvania. *Mining Bull.*, **4**, 106–7 (1898).

Hopkins, T. C.—Clays and Clay Industries of Pennsylvania. I. Clays of Western Penn. (In part.) Appendix to the *Ann. Rept., Pa. State Coll. for 1887*, Off. Doc., No. 21, 83 pp. (1898). Reviewed in *Eng. and Min. Jour.*, p. 243, Aug. 26 (1899).

Hopkins, T. C.—Clays and Clay Industries of Pennsylvania. II. Clays of Southeastern Pennsylvania. (In part.) *Ann. Rept. Pa. State Coll., 1898–99*, Appendix, **76** pp. (1900).

Hopkins, T. C.—Clays and Clay Industries of Pennsylvania. III. Clays of the Great Valley and South Mountain Areas. *Ann. Rept. Pa. State Col., 1899–1900*, Appendix, 45 pp. (1901). (Reviewed in *Jour. Geol.*, **10**, 545.)

Hopkins, T. C.—Conshohocken Plastic Clays (Pennsylvania). *Bull. Geol. Soc. Amer.*, **10**, 480–4 (1900). (Abs., *Amer. Geol.*, **23**, 102 (1899); *Science* (New Series), **9**, 139 (1899).)

Hopkins, T. C.—Feldspars and Kaolins of Southeastern Penna. *Jour. Franklin Inst.*, **148**, 1–31 (1899).

Hopkins, T. C.—The Fire Clays and Fire Clay Industry at Bolivar, Pa. *The Clayworker*, **31**, 423–6 (1899).

Hopkins, T. C.—The White Clays of Southeastern Pennsylvania. *Eng. and Min. Jour.*, **70**, 131 (1900).

Johnson, S. W.—Clay for Pottery and Kaolin. Pa. Sec. Geol. Surv., *Rept.* **B**, 118–20 (1874).

Lesley, J. P.—The Coal Beds and Fire Clays of the Wellersburg Basin in Sommerset County. (Pa.) Geol. Surv. Pa., *Ann. Rept.*, **1885**, pp. 227–39 (1886).

Lesley, J. P.—Some General Considerations Respecting the Origin and Distribution of the Delaware and Chester Kaolin Deposits. Pa. Geol. Surv., *Ann. Rept.*, pp. 571–91 (1885).

Lines, E. T.—The Clays and Shales in Clarion County, Pennsylvania. U. S. Geol. Surv., *Bull.* **315** (1906). (Abs. in *The Clayworker*, **48**, 267 (1907).)

Lovejoy, E.—Notes on Fire Clays of the Northern Appalachian Coal Basin. *Jour. Amer. Ceram. Soc.*, **2**, 374–90 (1919).

Mansfield, I. F.—Fire Clay, Coals and Titles of the Cannel Coal Tract at Cannelton, Beaver County, Pennsylvania. Beaver Falls, Pa., Tribune Printing Co., *Printers*, 1905 (Priv. Pub.).

McCreath, A. S.—Analyses of Fire Clays. Rept. **M3**, 2nd Geol. Surv., Pa., pp. 95–7 (1881).

McCreath, A. S.—Analyses of Clays and Fire Bricks. *Rept.* **MM**, 2nd Geol. Surv., Pa., pp. 257–79 (1879).

Moore, E. S.—White Clay Deposits in Central Pennsylvania. Pa. Bur. Top. and Geol. Surv., *Bull.* **45** (1922).

Morganroth, L. C.—Pennsylvania Fire Clay. *Bull. Amer. Inst. Min. Eng.*, **110**, 475–81 (1916) (with discussion by D. B. Reger), *Trans.*, **54**, 477–484 (1917).

Morrell, T. T.—Analyses of Fire Clays, in paper by F. Platt. Pa. Geol. Surv., *Rept.* **HH**, 1875, pp. 147, 148, 154 (1877).

Peck, F. B.—White Clay Deposits at Saylorsburg, Monroe County, Pennsylvania. Pa. Bur. Top. and Geol. Surv., *Bull.* **40** (1922). (Abs., *Bull. Geol. Soc. Amer.*, **30**, 96 (1919).)

Phalen, W. C.—Description of the Johnstown Quadrangle, Pennsylvania. U. S. Geol. Surv., Geol. Atlas, *Johnstown Folio*, No. **174** (1910). (Abs., *Jour. Wash. Acad. Sci.*, **2**, 135 (1912).)

Phalen, W. C. and Martin, L.—Clays and Shales of Southwestern Cambria County. U. S. Geol. Surv., *Bull.* **315**, 344–54 (1907). (Abs. in *Jour. Iron and Steel Inst.*, **75** [3], 342 (1907).)

Phalen, W. C. and Martin, L.—Mineral Resources of Johnstown, Pennsylvania and Vicinity. U. S. Geol. Surv., *Bull.* **447**, 113–26 (1911). (Abs., *Jour. Wash. Acad. Sci.*, **2**, 135 (1912).)

Platt, F.—Iron Ores and Fire Clays. 2nd Geol. Surv., Pennsylvania. *Report* **L**, p. 98 et seq. (1876).

Platt, F.—On the Cambria County Fire-Clays, etc. Analyses of Fire Clays. *Rept. of Progress* **HH.** 2nd Geol. Surv. of Penn., pp. 145–9 (1877).

Platt, F. and W. G.—Report of Progress in the Cambria and Sommerset District of the Bituminous Coal-Fields of Western Pennsylvania. Pa. Sec. Geol. Surv., *Rept.* **HHH.**, 169, 191, 124, 242 (1876).

Platt, W. G.—Report of Progress in

Armstrong County. Pa. Sec. Geol. Surv., *Rept.* **H5**, pp. 9, 12–5.

Platt, F.—Report of Progress in the Clearfield and Jefferson District of the Bituminous Coal Fields of Western Pennsylvania. Pa. Sec. Geol. Surv., *Rept.* **H**, pp. 128, 129, 177 (1874).

Platt, W. G.—Report of Progress in Indiana County. Pa. Sec. Geol. Surv., *Rept.* **HHHH**, 25, 89, 222 (1877).

Prime, F., Jr.—The Brown Hematite Deposits of the Siluro-Cambrian Limestones. Pa. Sec. Geol. Surv., *Rept.* **DD**, 24, 44, 45 (1878).

Rand, T. D.—Notes on the Geology of Radnor Township, Delaware County and of the Townships Adjacent to it. Pa. Sec. Geol. Surv., *Ann. Rept., Pt. IV*, 1604–1605 (1886).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, 208–41 (1903).

Ries, H.—Occurrence of Glass-Pot Clays in the United States. *Mineral Resources of the U. S. for 1901* (1902).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708**, 18, 82–99, 109–16, 135 (1921).

Rogers, H. D., Frazer, P. and Hall, C. E.—The Geology of Chester County. Pa. Sec. Geol. Surv., *Rept.* **C4**, 137, 167, 248, 274, 277, 279, 325, 329 (1883).

Spencer, G.—The Kaolin Beds of Chester County, Pa. and of New Castle County, Delaware. *Proc. Engineers' Club of Philadelphia*, **4**, 302–305 (1885); *Sci. Amer. Supp.*, **31**, p. 1, 2842.

Stevenson, J. J.—Report of Progress in the Fayette and Westmoreland District of the Bituminous Coal Fields of Western Pennsylvania. Pa. Sec. Geol. Surv., *Rept.* **KKK**, 248, 249, 253, 296–9 (1877).

Stevenson, J. J.—Report of Progress in the Green and Washington District of the Bituminous Coal Fields of Western Pennsylvania. Pa. Sec. Geol. Surv., *Rept.* **K**, 88, 389 (1875).

Stone, R. W.—Mineral Resources Elders' Ridge Quadrangle. U. S. Geol. Surv., *Bull.* **256**, 77–8 (1905). (Abs. in *Jour. Iron and Steel Inst.*, **69** [1], 319 (1906).)

Stose, G. W.—White Clays of South Mountain, Pa. U. S. Geol. Surv., *Bull.* **315**, 322–34 (1907). (Abs., *Geol. Centralb.*, **11**, 70 (1908).)

White, I. C.—The Geology of Huntingdon County. Pa. Sec. Geol. Surv., *Rept.* **T3**, 227, 228 (1885).

White, I. C.—The Geology of Pike and Monroe Counties. Pa. Sec. Geol. Surv., *Rept.* **66**, 171 (1881).

White, I. C.—Report of Progress in the Beaver River District of the Bituminous Coal Fields of Western Pennsylvania. Pa. Geol. Surv., *Rept.* **Q**, 13, 46, 57–9, 63, 96, 159, 161, 183, 190, 192–3, 195–6, 215, 224, 265 (1875).

Woolsey, L. H.—Clays of the Ohio Valley in Pennsylvania. U. S. Geol. Surv., *Bull.* **225**, Series A, *Econ. Geol.*, **33**, 463–81. (List of Survey publications on Clays and Fullers' Earth, p. 481.)

Woolsey, L. H.—Economic Geology of the Beaver Quadrangle, Pa. (Southern Beaver and Northwestern Alleghany Counties.) U. S. Geol. Surv., *Bull.* **286**, 132 pp. (1906).

Wright, G. F.—The Age of the Philadelphia Brick Clay. *Science*, New Ser., **3**, 242–3 (1896).

Rhode Island

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the United States, 1891*, p. 502 (1892).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, 241 (1903).

Shaler, N. S., Woodworth, J. B. and Marbut, C. F.—The Glacial Brick Clays of Rhode Island and Southeastern Massachusetts. U. S. Geol. Surv., *17th Ann. Rept.*, pp. 951–1004 (1896).

South Carolina

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148**, p. 290 (1897).

Hammond, H.—Kaolin. South Carolina, Resources and Population. pp. 120, 170, 608 (1883).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 506 (1892).

Lieber, O. M.—Clays. *1st Ann. Rept. Survey South Carolina*, pp. 97–9 (1858).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, 241–3 (1903).

Ries, H.—The Occurrence of High-Grade American Clays and the Possibilities of Their Further Development. *Jour. Amer. Ceram. Soc.*, **1** [7], 446–67 (1918).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708**, 79–82, 164–94, 211–22 (1921).

Sloan, E.—Catalogue of the Mineral Localities of South Carolina. S. Car. Geol. Surv., *Bull.* **2** [4] (1908).

Sloan, E.—Geology and Mineral Resources of S. Carolina. S. Car. State Dept. Agr., *Handbook of South Carolina*, pp. 77–145 (1907).

Sloan, E.—A Preliminary Report on the Clays of South Carolina. South Carolina Geol. Surv., *Bull.* **1**, 171 pp. (1904).

Watkins, J. H.—White-Burning Clays of the Southern Appalachian States. *Trans. Amer. Inst. Min. Eng.*, 51–492 (1915).

Weigel, W. M.—The White Clay Industry in the Vicinity of Langley, South Carolina. Bur. Mines, *Repts. Investigations*, No. **2322**, 6 pp. (1922).

South Dakota

Anon.—Fullers' Earth. *Min. Ind.*, **6**, 254 (1897).

Anon.—Fullers' Earth. *Min. Ind.*, **9**, 296–8 (1900).

Day, D. T.—Fullers' Earth. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (cont.)*, pp. 1351–3 (1897).

Day, D. T.—The Occurrence of Fullers' Earth in the United States. *Jour. Franklin Inst., Rept.* **CL**, 214–23 (1900). (Abs. in *Rev. Amer. Chem. Research*, **7**, 67–8.)

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522**, 329 (1913).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 524 (1892).

Ries, H.—The Fullers' Earth of South Dakota. *Trans. Amer. Inst. Min. Eng.*, **27**, 333–5 (1897).

Stanton, T. W.—A Cretaceous Volcanic Ash Bed on the Great Plains in South Dakota. *Jour. Wash. Acad. Sci.*, **7**, 80–1 (1917).

Steiger, G.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228**, 363 (1904).

Todd, J. E.—Preliminary Report on the Geology of South Dakota. S. Dak. Geol. and Nat. Hist. Surv., *Bull.* **1** (1894).

Todd, J. E.—The Clay and Stone Resources of South Dakota. *Eng. and Min. Jour.*, **66**, 371 (1898).

Todd, J. E.—First and Second Biennial Reports on the Geology of South Dakota with Accompanying Papers. S. Dak. Geol. and Nat. Hist. Surv., *Bull.* **2,** 131 pp. (1898).

Todd, J. E.—Mineral Building Materials, Fuels and Waters of South Dakota. S. Dak. Geol. and Nat. Hist. Surv., *Bull.* **3,** General, pp. 98, 101; Brick, pp. 104–6; China, p. 102; Fire, pp. 102–4; Fullers' Earth, pp. 107–8; Potters, p. 104 (1902).

Todd, J. E.—Mineral Resources of South Dakota. Fullers' Earth. S. Dakota Geol. Surv., *Bull.* **3,** 107–8 (1902).

Visher, S. S.—The Geography of South Dakota. S. Dak. Geol. and Nat. Hist. Surv., *Bull.* **8,** 21 (1918).

Visher, S. S.—Preliminary Report on the Geology, Geography and Biology of South-Central South Dakota. S. Dak. Geol and Nat. Hist. Surv., *Bull.* **5,** 60 (1912).

Ward, F.—Geology of a Portion of the Badlands. S. Dak. Geol. and Nat. Hist. Surv., *Bull.* **11,** 51–3 (1922).

Ward, F.—The Natural Resources of South Dakota. S. Dak. Geol. and Nat. Hist. Surv., *Circ.* **16,** 18–9 (1924).

Wherry, E. T.—Clay Derived from Volcanic Dust in the Pierre in S. Dakota. *Jour. Wash. Acad. Sci.,* **7** [19], 576–83 (1917).

Tennessee

Ashley, G. H.—Aluminum and Bauxite Mining in Tennessee. *Min. World,* **36,** 557–8 (1912).

Ashley, G. H.—Bauxite Mining in Tennessee. Tenn. Geol. Surv., *Resources of Tenn.,* **1** [6], 211–19 (1911).

Ashley, G. H.—Bauxite Mining in the State of Tennessee. *Min. Science,* **115,** 8–9 (1912).

Ashley, G. H.—The Clays of Tennessee. *Min. and Sci. Press,* **101,** 713 (1910).

Ashley, G. H.—Outline Introduction to the Mineral Resources of Tennessee. Tenn. Geol. Surv., *Bull.* **2A,** 1–65 (1910).

Crider, A. F.—Clays of Western Kentucky and Tennessee. U. S. Geol. Surv., *Bull.* **285,** 417–27 (1906).

Currey, R. P.—A Sketch of the Geology of Tennessee. Alum Shales, p. 30–1 (1857).

Eckel, E. C.—Stoneware and Brick Clays of Western Tennessee and Northwestern Mississippi. U. S. Geol. Surv., *Bull.* **213,** 382–91 (1903). (Abs., *Geol. Centralb.,* **5,** 57 (1904).)

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 516 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893,* pp. 609, 610 (1894).

Kirkpatrick, F. A.—Tests on the Clays of Henry County. Tenn. Geol. Surv., *Resources of Tenn.,* **2** [11], 18 (1912).

Miser, H. D.—Mineral Resources of the Waynesboro Quadrangle Tennessee. Tenn. Geol. Surv., *Bull.* **26,** 142 (1921).

Nelson, W. A.—Appalachian Bauxite Deposits. *Bull. Geol. Soc. Amer.,* **34,** 525–40 (1923).

Nelson, W. A.—Clay Deposits of West Tennessee. State of Tennessee, *Bull. Geol. Surv.,* **5,** 18 (1911).

Nelson, W. A.—Great Possibilities in Tableware Manufacturing. *Bull. Tenn. Geol. Surv.,* **23,** 3 (1920).

Nelson, W. A.—Lignite and Lignitic Clays in West Tennessee. Tenn. Geol. Surv., *Resources of Tenn.,* **2** [4], 4 (1912).

Nelson, W. A.—Mid-Ordovicic Volcanic Ash in Tennessee (Bentonite). *Pan-Amer. Geologist,* **37,** 251 (1922).

Nelson, W. A.—Mineral Products along the Tennessee Central Railroad. Tenn. Geol. Surv., *Resources of Tenn.,* **3** [3] (1913).

Nelson, W. A.—Notes on a Volcanic Ash Bed in the Ordovician of Middle

Tennessee. Tenn. Geol. Surv., *Bull.* **25,** 3 (1920).

Nelson, W. A.—Tennessee Ball Clay and Its Manufacturing Possibilities. *Manufact. Rec.*, p. 3, Feb. 17 (1921).

Nelson, W. A.—Volcanic Ash Bed in Ordovician of Tennessee, Kentucky and Alabama. *Bull. Geol. Soc. Amer.*, **33,** 605–16 (1922).

Parmelee, C. W.—Characteristic Properties of Ball and Plastic Refractory Bond Clays. Tenn. Geol. Surv., *Resources of Tenn.*, **9** [2], 191 pp. (1919).

Purdue, A. H.—Bauxite in Tennessee. Tenn. Geol. Surv., *Resources of Tenn.*, **4** [2], 87–91 (1914).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 243–8 (1903).

Ries, H.—The Occurrence of High Grade American Clays and the Possibilities of Their Further Development. *Jour. Amer. Ceram. Soc.*, **1** [7], 446–67 (1918).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708,** 222–3, 225–30, 236, 260–75 (1921).

Schaller, W. T.—Analyses of Tennessee Clays. U. S. Geol. Surv., *Bull. Analyses of Rocks, 1880 to 1903,* **228,** p. 358 (1904).

Schroeder, R. A. and Parmelee, C. W.—Ball Clays of West Tennessee. Tenn. Geol. Surv., *Resources of Tenn.*, **9** [2], 81–180, No. 2 (1919).

Sortwell, H. H.—The Properties of Some Ball Clays. *The Ceramist,* **2** [1], 5–15 (1922).

Watkins, J. H.—Bauxite near Elizabethtown, Tenn. *Eng. Min. Jour.*, **95,** 604–5 (1913).

Watkins, J. H.—White Burning Clays of the Southern Appalachians. *Trans. Amer. Inst. Min. Engrs.*, **51,** 496 (1916).

Texas

Deussen, A.—Notes on Some Clays from Texas. U. S. Geol. Surv., *Bull.* **470,** 302–51 (1911).

Drake, N. F. and Thompson, R. A.—The Colorado Coal Field of Texas. Tex. Geol. Surv., *4th Ann. Rept.*, p. 357 (1893).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 345 (1913).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* pp. 518–22 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1892,* pp. 724, 735–7 (1893).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893,* p. 610 (1894).

Kennedy, W.—Texas Clays and Their Origin. *Science,* **22,** 297–300 (1893).

Kruson, J. H.—Refractory Clays of Texas. *Jour. Amer. Ceram. Soc.*, **5,** 643–5 (1922).

Mayer, A.—Notes on Texas Kaolin. *Trans. Amer. Ceram. Soc.*, **10,** 91 (1908).

Merrill, G. P.—Non-Metallic Minerals, 2d Ed., 229 (1910). Halloysite.

Richardson, G. B.—Portland Cement Materials near El Paso, Tex. U. S. Geol. Surv., *Bull.* **340,** pp. 411–4 (1908).

Ries, H.—The Clays of Texas. *Trans. Amer. Inst. Min. Eng.*, **37,** 520–58 (1907).

Ries, H.—The Clays of Texas. *Bull. Univ. of Tex.*, **102,** 316 pp. (1908). (Abs., *Geol. Centralb.*, **12,** 549 (1909).

Ries, H.—A Peculiar Type of Clay. *Amer. Jour. Sci.*, **44** [4], 316–8 (1917).

Taff, J. A. and Leverett, S.—The Cretaceous Area North of the Colorado River. Tex. Geol. Surv., *4th Ann. Rept.* p. 241 (1893).

Wilson, J. M.—Potteries, Clays, Etc., in Western Texas. Tex. Almanac, pp. 144–6 (1870).

Utah

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 299 (1897).

Greaves-Walker, A. F.—The Commercial Clays of Utah. *Trans. Amer. Ceram. Soc.,* **13,** 277 (1911).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* 526 (1892).

Russell, I. C.—Subaerial Deposits of North America. *Geol. Mag.,* **6,** 289, 342 (1889). Adobe Clay.

Vermont

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 277–9 (1897).

Dewey, C.—Porcelain Clay. (Pownal, Vt.) *Amer. Jour. Sci.,* **12,** 298–9 (1827).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 502 (1892).

Hunt, T. S.—Analyses of Clays. *3rd Ann. Rept. Geology, Vermont,* p. 8 (1848).

Hunt, T. S.—Analyses of Clays. *4th Ann. Rept. Geology, Vermont,* p. 8 (1848).

Nevius, J. N.—Kaolin in Vermont. *Eng. and Min. Jour.,* **64,** 189 (1897).

Perkins, G. H.—Mineral Resources of the State. Kaolin and Fire Clay. *Rept. Vt. State Geologist, 1903,* p. 52 (1904).

Perkins, G. H.—Mineral Resources of the State. Clays at Rutland. *Rept. Vt. State Geologist, 1907–8,* p. 46 (1908).

Perkins, G. H.—Mineral Resources of Vermont. Bennington clay. *Rept. Vt. State Geologist, 1911–12,* p. 266 (1912).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 132 (1903).

Woodworth, J. B.—The Brandon Clays. *Rept. Vt. State Geologist, 1903–4,* p. 166 (1904).

Virginia

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 289 (1897).

Darton, N. H.—Economic Geology of Richmond, Va., and Vicinity. U. S. Geol. Surv., *Bull.* **483,** 48 pp. (1911).

Day, D. T.—The Occurrence of Fullers' Earth in the United States. *Jour. Franklin Inst.,* **150,** 214–23 (1900). (Abs. in *Rev. Amer. Chem. Research,* **7,** 67–68.)

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **243,** 317, 320, 322 (1905).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 505 (1892).

Heyward, B. H.—A Zinc-Bearing Clay from Virginia. *Chem. News,* **60,** 207. (Abs., *Jour. Chem. Soc.* (London), **42,** 24 (1882).)

Heinrich, O. J.—The Mesozoic Formation in Virginia. (Ceramic Clays.) *Trans. Amer. Inst. Min. Eng.,* **6,** 273.

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893,* pp. 610, 611 (1894).

Merrill, G. P.—Residual Clay of Limestone from Staunton, Augusta County, Va. Analyses. U. S. Geol. Surv., *Bull.* **150,** 384–85 (1898). (See also *Trans. Amer. Soc. Civ. Eng.,* **24,** 552 (1893).)

Moxham, E. C.—Zinc Smelting at the Bertha Works, Virginia. (Analyses of Fire Clay.) *Eng. and Min. Jour.*, **56**, 544 (1893).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, 248–52 (1903).

Ries, H.—Clays of the Virginia Coastal Plain. Va. Geol. Surv., *Bull.* **2**, 25–176 (1906).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708**, 18, 99–104 (1921).

Ries, H. and Somers, R. E.—The Clays of the Piedmond Province, Va. Va. Geol. Surv., *Bull.* **13**, 86 pp. (1917).

Ries, H. and Somers, R. E.—The Clays and Shales of Virginia West of the Blue Ridge. Va. Geol. Surv., *Bull.* **20**, 118 pp. (1920).

Steiger, G.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228**, 354 (1904).

Valentine, E. R.—On a Decomposition Product of Allanite, a Variety of Kaolinite, from Nelson County, Va. *Am. Chem. Jour.*, **7**, 178–80 (1885–86).

Watson, T. L.—Economic Products of the Virginia Coastal Plain. Va. Geol. Surv., *Bull.* **4**, 223–63 (1912).

Washington

Anon.—New Kaolin Deposits Formed in the State of Washington. *The Clay-worker*, **78**, 127 (1922).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148**, 301 (1897).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522**, 360–4 (1913).

Geijsbeek, S.—The Clay Deposits of Washington. *Trans. Amer. Ceram. Soc.*, **13**, 751–64 (1911).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, pp. 525, 526 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1892*, p. 738 (1893).

Hillebrand, W. T.—Analyses of Rocks, 1880–1903. U. S. Geol. Surv., *Bull.* **228**, 370 (1904).

Landes, H.—The Clay Deposits of Washington. Contributions to Economic Geology, 1904. U. S. Geol. Surv., *Bull.* **260**, 550–8 (1905).

Landes, H.—The Non-Metalliferous Resources of Washington, except Coal. (Clay Materials.) Washington Geol. Surv., *Annual Rept. for 1901*, **1**, 173–4 (1902).

Shedd, S.—The Clays of the State of Washington, Their Geology, Mineralogy and Technology. 341 pp. (1910).

Wilson, H., Bennett, A. L. and Heath, F. T.—Preliminary Report on the Residual Kaolin and Feldspar in the Pacific Northwest. *Jour. Amer. Ceram. Soc.*, **6**, 475–90 (1923).

Wilson, H.—The Clays and Shales of Washington, Their Technology and Uses. Univ. Wash., Eng. Expt. Sta., *Bull.* **18** (1923).

West Virginia

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **243**, 328 (1905). (A later edition, *Bull.* **522.**)

Grimsley, G. P.—Clays, Limestones and Cements. W. Va. Geol. Surv., **3**, 565 pp. (1907). (Abs., *Eng. and Min. Jour.*, **81**, 1058 (1906).)

Grimsley, G. P.—Report on Ohio, Brooke and Hancock Counties. W. Va. Geol. Surv., 378 pp. (1907).

Grimsley, G. P.—Report on Pleasants, Wood and Ritchie Counties. W. Va. Geol. Surv., 352 pp. (1910).

Hennen, R. V.—Report on Doddridge and Harrison Counties. W. Va. Geol. Surv., 712 pp. (1912).

Hennen, R. V.—Report on Marshall, Wetzel and Tyler Counties. W. Va. Geol. Surv., 654 pp. (1909).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 515 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1892*, p. 724 (1893).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893*, p. 611 (1894).

Krebs, C. E.—Report on Jackson, Mason and Putnam Counties. W. Va. Geol. Surv., 387 pp. (1911).

Phalen, W. C.—Economic Geology of the Kenova Quadrangle, Kentucky, Ohio and West Virginia. U. S. Geol. Surv., *Bull.* **349**, 158 pp. (1908).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, 252–62 (1903).

Wisconsin

Alden, W. C.—Description of the Milwaukee Quadrangle, Wis. U. S. Geol. Surv., Geol. Atlas, *Milwaukee Folio*, **140**, 12 pp. (1906).

Berkey, Charles P.—Laminated Interglacial Clays of Grantsburg, Wis. *Jour. Geol.*, **13** [1], 35–45 (1905).

Buckley, E. R.—The Clays and Clay Industries of Wisconsin. Wis. Geol. and Nat. Hist. Surv., *Bull.* **7**, Pt. 1, Econ. Ser., No. 4 (1901).

Chamberlin, T. C.—Color of Milwaukee Bricks and Analyses of Clays. *Geol. of Wis.*, **1**, 668–73 (1883), **2**, 235–9 (1877).

Chamberlin, T. C. and Salisbury, R. D.—The Driftless Area of the Upper Mississippi. *6th Annual Rept. Geol. Surv. for Year, 1884–85*, pp. 199–322 (1885). (Analyses of Residual and Glacial Clays, p. 250.)

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 283, 294 (1897).

Daniels, E.—Clay in Wisconsin. *Mining Mag.*, **2,** 346 (1854).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, 522, 523 (1892).

Irving, R. D.—The Geology of Central Wisconsin. Geol. of Wisconsin, **2**, 465–524 (1877).

Irving, R. D.—Kaolin in Wisconsin. *Trans. Wis. Acad. Sci.*, **3**, pp. 3–30 (1875–76). Republished without credit in *The Brickmaker* for Sept. 15 and Oct. 1, 1890; Long extracts from it in same publication for Oct., 1892.

Irving, R. D.—The Mineral Resources of Wisconsin. (Brick, Clays and Kaolin.) *Trans. Am. Inst. Min. Eng.*, **8**, 502–6 (1879–80).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, 262–73 (1903).

Ries, H.—The Clays of Wisconsin and Their Uses. Wis. Geol. and Nat. Hist. Surv., *Bull.* **15**, Econ. Series, No. 10 (1906).

Riggs, R. B.—Analyses of Four Residuary Clays from Wisconsin. U. S. Geol. Surv., *Bull.* **27**, 67, 68 (1886).

Salisbury, R. D.—Chemical Analyses of Clays. *Geol. of Wisconsin*, **1**, 306 (1883).

Sweet, E. T.—Milwaukee Clays and Bricks. (Analyses of Clays.) *Amer. Jour. Sci.*, 3rd Ser., **24**, 154 (1882).

Also Geology of Wisconsin, **1**, 669 (1873–9).

Weidman, S.—The Geology of North Central Wisconsin. Wis. Geol. and Nat. Hist. Surv., *Bull.* **14**, Sci. Ser., No. 4 (1907).

Wyoming

Bastin, E. S.—Note on the Baked Clays and Natural Slags in Eastern Wyoming. *Jour. Geol.*, **13**, 408–12 (1905). (Abs., *Geol. Centralb.*, **7**, 689 (1905–06).)

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148**, 299 (1897).

Darton, N. H.—Bentonite in Wyoming. U. S. Geol. Surv., Geol. Atlas, *Folio*, **107**, 5, 9 (1904).

Darton, N. H. and Siebenthal, C. E.—Geology and Mineral Resources of Laramine Basin, Wyo. U. S. Geol. Surv., *Bull.* **364**, 34, 58–61 (1909).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522**, 374 (1913).

Fisher, C. A.—The Bentonite Deposits of Wyoming. U. S. Geol. Surv., *Bull.* **260**, 559–63 (1905). (Abs., *Geol. Centralb.*, **8**, 34 (1906).)

Fisher, C. A.—Geology of Bighorn Basin, Wyo. U. S. Geol. Surv., *Prof. Paper* **53**, 29, 56–8 (1906).

Fisher, C. A.—Mineral Resources of the Bighorn Basin. U. S. Geol. Surv., *Bull.* **285**, 311–5 (1906).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 524 (1892).

Knight, W. C.—Bentonite. *Eng. Min. Jour.*, **66**, 491 (1898).

Knight, W. C.—The Building Stones and Clays of Wyoming. *Eng. Min. Jour.*, **66**, 546–7 (1898).

Knight, W. C.—"Mineral Soap." (Analyses of Clays from Wyoming.) *Eng. Min. Jour.*, **63**, 600–1 (1897).

Ohly, J.—The Occurrence of Bauxite in Colorado and Wyoming, and Its Utilization. (1st Part.) *Min. Reporter*, Denver, Sept. 12 (1901).

Ries, H.—The Clay-Working Industry in 1896. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (cont.), 1896–97*, pp. 1145, 1146 (1897).

Siebenthal, C. E.—Bentonite of the Laramine Basin, Wyo. U. S. Geol. Surv., *Bull.* **285**, 445–7.

Wherry, E. T.—Bentonite in Wyoming. U. S. Geol. Surv., *Bull.* **624**, 342 (1917).

CANADA

Alberta

Allan, J. A.—Bentonite. Sci. Ind. Research Council of Alberta, Min. Res. *1st Ann. Rept., 1919*, p. 41; *2nd Ann. Rept., 1920*, p. 36; *3rd Ann. Rept., 1921*, pp. 21, 35–9, 43, 58, 65; *4th Ann. Rept., 1922, Pt. I*, pp. 62–4.

Ella, S. C.—Clay Deposits near Mac Murray, Alberta. Canada Dept. Mines., *Bull.* **10**, 15 pp. (1915).

Hoffmann, G. C.—Soap Clay. Can. Geol. Surv., *Rept. of Progress, 1873–4*, 64.

Keele, J.—Report on Progress of Investigation of Clay Resources. Can. Geol. Surv., *Sum. Rept., 1911*, p. 234–9 (1912).

Keele, J.—Clay and Shale Deposits of the Western Provinces. Part V. Canada Geol. Surv., *Memoir*, **66** (1915).

Keele, J.—Notes on Bentonite. Can. Mines Branch, *Sum. Rept., 1918*, pp. 159–61.

Reat, S. C.—Ceramic Resources of Alberta. *Commerce Reports*. (Abs. in *The Clayworker*, **64**, 514 (1915).)

Ries, H.—Clay and Shale Deposits of the

Western Provinces of Canada. Can. Geol. Surv., *Sum. Rept., 1910*, pp. 174–80 (1911).

Ries, H.—The Clay and Shale Deposits of the Western Provinces of Canada. Can. Min. Inst., *Trans.*, **14**, 351–94 (1911). (Abs., *Geol. Centralb.*, **17**, 637 (1911–12).)

Ries, H.—Report on Progress of Investigations of Clay Resources. Can. Geol. Surv., *Sum. Rept., 1911*, p. 225–9 (1912).

Ries, H.—Clay Investigations in Western Canada. Can. Geol. Surv., *Sum. Report, 1912*, 229–33 (1914).

Ries, H.—Clay and Shale Deposits of the Western Provinces. Part III. Can. Geol. Surv., *Memoir*, **47** (1914).

Ries, H.—The Clay and Shale Deposits of the Western Provinces. Part IV. Can. Geol. Surv., *Memoir*, **65** (1915).

Ries, H.—Clays of British Columbia and Alberta. Can. Geol. Surv., *Sum. Rept., 1913*, pp. 284–7 (1914).

Ries, H. and Keele, J.—Preliminary Report on the Clay and Shale Deposits of the Western Provinces. Can. Geol. Surv., *Memoir*, **24**, 231 pp. (1912).

Ries, H. and Keele, J.—Report of the Clay and Shale Deposits of the Western Provinces. Part II. Can. Geol. Surv., *Memoir*, **25** (1913).

Selwyn, A. R. C.—Bentonite. Can. Geol. Surv., *Rept. of Progress, 1873–74*, p. 38.

Tyrrell, J. B.—Report on a Part of Northern Alberta, and Portions of Adjacent Districts of Assiniboia and Saskatchewan, Embracing the Country Lying South of the North Saskatchewan River and North of Lat. 51°6′, and between Long. 110° and 115°15′ W. Can. Geol. Surv., *Ann. Rept.*, **2**, 151E (1887).

Spence, H. S.—Bentonite. Can. Mines Branch, No. 626 (1924).

British Columbia

Anon.—Kaolin in British Columbia. *Mine, Quarry and Derrick*, Apr. 14, p. 186 (1915).

Anon.—Kaolin Deposits in British Columbia. *Pottery Gaz.*, **47**, 1702 (1922).

Anon.—Clay in British Columbia. *British Clayworker*, **31**, 360 (1922–23).

Anon.—Canadian Kaolin. *Raw Mat. Rev.*, **2**, 97 (1923).

Bell, R.—Summary Report on the Operations of the Geological Survey for the Calendar Year 1902. Can. Geol. Surv., *Ann. Rept.*, **15**, 133A (1903).

Brummell, H. P. H.—Division of Mineral Statistics and Mines Annual Report for 1892. Can. Geol. Surv., *Ann. Rept.*, **6**, 45S (1894).

Camsell, C.—Coast Range, Lytton to Vancouver; Fire Clay Deposits at Clayburn, B. C. 12th Int. Geol. Cong., *Can. Guide Book*, No. **8**, 256–74, 343–9 (1913).

Camsell, C.—Note on the Occurrence of Diatomaceous Earth, Clay and Magnesite along the Route of the Pacific Great Eastern Railway. Can. Geol. Surv., *Sum. Rept., 1917, Pt. B.*, pp. 25–8 (1918).

Clapp, C. H.—Sooke and Duncan Map Areas, Vancouver Island. Can. Geol. Surv., *Mem.*, **96**, 397–9 (1917).

Dawson, G. M.—Summary Report on the Operations of the Geological Survey for the Year 1894. Can. Geol. Surv., *Ann. Rept.*, **7**, 16A (1895).

Dawson, G. M.—Report on the Area of the Kamloops Map-Sheet British Columbia. Can. Geol. Surv., *Ann. Rept.*, **7**, 80B, 346B (1895).

Hoffmann, G. C.—Chemical Contributions to the Geology of Canada from the Laboratory of the Survey. Can. Geol. Surv., *Ann. Rept.*, **6**, 91R (1895); **12**, 61R (1901); **13**, 61R (1903).

Ingall, E. D.—Section of Mines Annual Report for 1902. Can. Geol. Surv., *Ann. Rept.*, **15**, 76S (1903).

Johnston, W. A.—Geology of the Frazer River Delta Map Area. Can. Geol.

Surv., *Mem.*, **135**, 74–5 (1923).

Keele, J.—Clay and Shale Deposits of the Western Provinces. Part V. Can. Geol. Surv., *Memoir*, **66** (1915).

Keele, J.—Refractory Materials of Canada. Can. Mines. Branch, *Sum. Rept., 1916*, p. 111.

Keele, J.—Investigations of Clay and Shale Resources. Can. Mines Branch, *Sum. Rept., 1918*, p. 153.

Reinecke, L.—Undeveloped Mineral Resources of the Clinton District, B. C. *Trans. Can. Min. Inst.*, **22**, 343 (1919).

Reinecke, L.—Mineral Deposits between Lillooet and Prince George, B. C. Can. Geol. Surv., *Memoir*, **118**, 129 pp. (1920).

Ries, H.—Clay and Shale Deposits of the Western Provinces of Canada. Can. Geol. Surv., *Sum. Rept., 1910*, pp. 174–80 (1911).

Ries, H.—The Clay and Shale Deposits of the Western Provinces of Canada. *Trans. Can. Min. Inst.*, **14**, 351 (1911).

Ries, H.—Report on Progress of Investigation of Clay Resources. Can. Geol. Surv., *Sum. Rept., 1911*, pp. 225–9 (1912).

Ries, H.—Clay Investigations in Western Canada. Can. Geol. Surv., *Sum. Rept., 1912*, pp. 229–33 (1914).

Ries, H.—Clays of British Columbia and Alberta. Can. Geol. Surv., *Sum. Rept., 1913*, pp. 284–7 (1914).

Ries, H.—The Clay and Shale Deposits of the Western Provinces of Canada. Part III. Can. Geol. Surv., *Memoir*, **47** (1914).

Ries, H.—The Clay and Shale Deposits of the Western Provinces. Part IV. Canada Geol. Surv., *Memoir*, **65** (1915).

Ries, H. and Keele, J.—Preliminary Report of the Clay and Shale Deposits of the Western Provinces. Can. Geol. Surv., *Memoir*, **24**, 231 pp. (1912).

Ries, H. and Keele, J.—Report of the Clay and Shale Deposits of the Western Provinces. Part II. Can. Geol. Survey, *Memoir*, **25** (1913).

Robertson, W. F.—Fire Brick Manufactured at Clayburn, British Columbia. Minister of Mines, Brit. Col., *Annual Rept.*, **28** (1921).

Spence, H. S.—An Addition to the Mineral Resources of Canada. Bentonite or Colloidal Clay. *Jour. Inst. Petrol. Tech.*, **10**, 707–9 (1924).

Spence, H. S.—Bentonite. Can. Mines Branch, *Rept.*, **626** (1924).

Manitoba

Bell, R.—Summary Report on the Operations of the Geological Survey for the Year 1903. Can. Geol. Surv., *Ann. Rept.*, **15**, 187–8AA (1904).

Davis, N. B.—Tests of Clay and Shales from Pembina Mountains in South Manitoba. Can. Mines Branch, *Rept.*, p. 117 (1916).

Dowling, D. B.—Report on the Geology of the West Shore and Islands of Lake Winnipeg. Can. Geol. Surv., *Ann. Rept.*, **11**, 11F (1900).

Harrington, B. J.—Notes of Samples of Brick Clay from Ft. Garry. Can. Geol. Surv., *Rept. Prog., 1873–74*, pp. 296–300 (1873).

Hoffmann, G. C.—Tests of Brick Clay from Souris City. Geol. Surv. of Can. *Prog. Rept., 1880–82*, pp. 2–4 (1883).

Johnston, W. A.—Semi-Refractory Clay and Pure Quartz Sand of Swan River Valley (Manitoba). Can. Geol. Surv., *Sum. Rept., 1917, Pt. II*, pp. 37–9 (1918).

Keele, J.—Clay Resources of the Western Provinces. Can. Geol. Surv., *Sum. Rept., 1910*, pp. 181–2 (1911).

Keele, J.—Clay and Shale Deposits of the Western Provinces. Part V. Can. Geol. Surv., *Memoir*, **66** (1915).

Keele, J.—Refractory Materials in Can-

ada. Can. Mines Branch, *Sum. Rept., 1916*, p. 111.

Keele, J.—Investigations of Clay and Shale Resources of Canada. Can. Mines Branch, *Sum. Rept., 1917*, pp. 97–120.

Keele, J.—Report on Progress of Investigation of Clay Resources. Can. Geol. Surv., *Sum. Rept., 1911*, pp. 234–9 (1912).

McConnell, R. G.—Report on the Cypress Hills Wood Mountain and Adjacent Country Embracing That Portion of the District of Assiniboia Lying between the International Boundary and the 51st Parallel and Extending from Long. 106° to Long. 110° 50′. Can. Geol. Surv., *Ann. Rept.*, **1**, 77–8C (1885).

Ries, H.—The Clay and Shale Deposits of the Western Provinces of Canada. Can. Min. Inst., *Trans.*, **14**, 351–94 (1911–12). (Abs., *Geol. Centralb.*, **17**, 637 (1911–12).)

Ries, H.—Report on Progress of Investigation of Clay Resources. Can. Geol. Surv., *Sum. Rept., 1911*, pp. 225–9 (1912).

Ries, H.—Clay and Shale Deposits of the Western Provinces. Part III. Can. Geol. Surv., *Memoir*, **47** (1914).

Ries, H. and Keele, J.—Preliminary Report on the Clay and Shale Deposits of the Western Provinces. Can. Geol. Surv., *Memoir*, **24**, 231 pp. (1912).

Ries, H. and Keele, J.—Report of the Clay and Shale Deposits of the Western Provinces. Part II. Can. Geol. Surv., *Memoir*, **25** (1913).

Upham, W.—Report on Exploration of the Glacial Lake Agassiz in Manitoba. Can. Geol. Surv., *Ann. Rept.*, **4**, 109–10E (1890).

Wells, J. W.—Preliminary Report on the Industrial Value of the Clays and Shales of Manitoba. Dept. of Interior, Mines Branch, 68 pp. (1905). (Abs., *Geol. Centralb.*, **7**, 588 (1905–06).)

New Brunswick

Bailey, L. W.—The Mineral Resources of the Province of New Brunswick. Can. Geol. Surv., *Ann. Rept.*, **10**, 115–8M (1898).

Bailey, L. W.—Report on Explorations in Portions of the Counties of Victoria Northumberland and Restigouche, New Brunswick. Can. Geol. Surv., *Ann. Rept.*, **2**, 19N (1887).

Bell, R.—Summary Report on the Operations of the Geological Survey for the Calendar Year 1902. Can. Geol. Surv., *Ann. Rept.*, **15**, 381A (1903).

Chalmers, R.—Preliminary Report on the Surface Geology of New Brunswick. Can. Geol. Surv., *Ann. Rept.*, **16**, 58GG (1885).

Chalmers, R.—Report on the Surface Geology of Northern New Brunswick and Southeastern Quebec. Can. Geol. Surv., *Ann. Rept.*, **2**, 38M (1887).

Chalmers, R.—Report on the Surface Geology of Northeastern New Brunswick. Can. Geol. Surv., *Ann. Rept.*, **3**, 32N (1888).

Chalmers, R.—Report on the Surface Geology of Southern New Brunswick. Can. Geol. Surv., *Ann. Rept.*, **4**, 91N (1890).

Chalmers, R.—Report on the Surface Geology of Eastern New Brunswick, Northwestern Nova Scotia and a Portion of Prince Edward Island. Can. Geol. Surv., *Ann. Rept.*, **7**, 147M (1895).

Chalmers, R.—Report on the Surface Geology Shown on the Frederickton and Andover Quarter-Sheet Maps, New Brunswick. Can. Geol. Surv., *Ann. Rept.*, **12**, 41M (1901).

Hoffmann, G. C.—Report of the Section of Chemistry and Mineralogy. Can. Geol. Surv., *Ann. Rept.*, **13**, 59R (1903).

Ingall, E. D.—Division of Mineral Statistics and Mines Annual Report for

1890. Can. Geol. Surv., *Ann. Rept.*, **5**, 12S (1891).

Keele, J.—Notes on Tests of Clay Samples. Can. Geol. Surv., *Sum. Rept., 1911*, pp. 233–4 (1912).

Keele, J.—Report on Progress of Investigation of Clay Resources. Can. Geol. Surv., *Sum. Rept., 1911*, pp. 234–9 (1912).

Keele, J.—Clay and Shale Deposits of New Brunswick, Can. Geol., *Surv. Memoir*, **44** (1914).

Keele, J.—Refractory Materials in Canada. Can. Mines Branch, *Sum. Rept., 1916*, p. 111.

Keele, J.—Investigations of Clay and Shale Resources of Canada. Can. Mines Branch, *Sum. Rept., 1917*, pp. 97–120.

Ries, H. and Keele, J.—The Clay and Shale Deposits of Nova Scotia and Portions of New Brunswick. Geol. Surv. of Can., *Memoir*, **16**, 164, (1911). (Abs., *Geol. Centralb.*, **17**, 636 (1911–12).)

Selwyn, A. R. C.—Summary Report of the Operations of the Geological Survey for the Years 1884 and 1885. Can. Geol. Surv., *Ann. Rept.*, **1**, 20A (1886); **4**, 42A (1890); **5**, 56A (1893).

Northwestern Territory

Dawson, G. M.—Notes to Accompany a Geological Map of the Northern Portion of the Dominion of Canada, East of the Rocky Mountains. Can. Geol. Surv., *Ann. Rept.*, **2**, 18R (1887).

Hoffmann, G. C.—Report of the Section of Chemistry and Mineralogy. Can. Geol. Surv., *Ann. Rept.*, **6**, 88–9R (1895); **12**, 60–1R (1901); **13**, 61R (1903).

Ingall, E. D.—Division of Mineral Statistics and Mines, Annual Report for 1892. Can. Geol. Surv., *Ann. Rept.*, **6**, 78S (1894).

McConnel, J.—Yukon and Mackenzie Basins, N. W. T. Can. Geol. Surv., *Ann. Rept.*, **6**, 99D (1888–89).

Nova Scotia

Anon.—Fire Clay in Nova Scotia. *British Clayworker*, **14**, 227 (1905–06).

Bailey, L. W.—Report on the Geology of Southwest Nova Scotia. Can. Geol. Surv., *Ann. Rept.*, **9**, 20M, 150M (1898).

Bell, R.—Summary Report on the Operations of the Geological Survey for the Year 1903. Can. Geol. Surv., *Ann. Rept.*, **15**, 163AA, 186AA (1904).

Chalmers, R.—Report on the Surface Geology of Eastern New Brunswick, Northwestern Nova Scotia and a Portion of Prince Edward Island. Can. Geol. Surv., *Ann. Rept.*, **7**, 147M (1895).

Dawson, G. M.—Summary Report on the Operations of the Geological Survey for Different Years as Follows: Can. Geol. Surv., *Ann. Rept.*, **7**, 95A (1895); **8**, 110A (1896); **9**, 93A, 97A (1897).

Faribault, E. R.—Clays in Lunenburg County, Nova Scotia. Can. Geol. Surv., *Sum. Rept., 1912*, p. 383 (1914).

Fletcher, H.—Report on Geological Surveys and Explorations in the Counties of Pictou and Colchester, Nova Scotia. Can. Geol. Surv., *Ann. Rept.*, **5**, 156P, 189–90P (1892).

Fletcher, H. and Faribault, E. R.—Report on Geological Surveys and Explorations in the Counties of Guysborough, Antigonish, Pictou, Colchester and Halifax, Nova Scotia, from 1882 to 1886. Can. Geol. Surv., *Ann. Rept.*, **2**, 16P, 125P, 163P (1887).

Flynn, A. E.—Report on China Clay (Kaolin) Deposit at Middleton, Annapolis County, Nova Scotia. Dept. of Public Works and Mines, p. 269 (1924).

Hoffmann, G. C.—Chemical Contributions to the Geology of Canada from the Laboratory of the Survey. Can. Geol. Surv., *Ann. Rept.*, **6**, 87–8R (1895); **9**, 52R (1898); **11**, 55R (1900); **12**, 60R (1901); **13**, 59R (1903).

Keele, J.—Clays and Shales in the Maritime Provinces. Can. Geol. Surv., *Sum. Rept., 1909*, pp. 245–6 (1910).

Keele, J.—Refractory Materials in Canada. Can. Mines Branch, *Sum. Rept., 1916*, p. 111.

Keele, J.—Investigations of Clay and Shale Resources of Canada. Can. Mines Branch. *Sum. Rept., 1917*, pp. 97–120.

Mason, F. H.—Potters Clay at Middle Musquodoboit (Nova Scotia). Can. Min. Rev., **20**, 175–6 (1901). (Abs., *Geol. Centralb.*, **3**, 329 (1903).)

Poole, H. S.—Report on the Pictou Coal Field, Nova Scotia. Can. Geol. Surv., *Ann. Rept.*, **14**, 12, 36–8 (1904).

Ries, H.—The Clay and Shale Deposits of Nova Scotia. *Jour. Min. Soc.*, **15**, 9–26 (1910). (Abs., *Geol. Centralb.*, **16**, 84 (1911).)

Ries, H. and Keele, J.—The Clay and Shale Deposits of Nova Scotia and Portions of New Brunswick. Geol. Surv. of Can., *Memoir*, **16**, 164 pp. (1911). (Abs., *Geol. Centralb.*, **17**, 636 (1911–12).)

Selwyn, A. R. C.—Summary Reports of the Operations of the Geological Survey for the Years 1887 and 1888. Can. Geol. Surv., *Ann. Rept.*, **1**, 23A (1886); **3**, 99A (1887–88); and for 1890, **5**, 59AA (1893); 1892, **6**, 53A (1895).

Ontario

Anon.—Mattagami China Clay Deposits. Can. Chem. and Met., **8** [11], 266 (1924).

Baker, M. B.—Clays and Clay Industries of Ontario. *The Clayworker*, **45**, 850 (1906).

Baker, M. B.—Clays of Ontario. *Can. Min. Jour.*, **30**, 244–5 (1909).

Baker, M. B.—Our Visible Supply of Brick. *Can. Min. Jour.*, **30**, 100–2 (1909).

Baker, M. B.—Clay and the Clay Industry of Ontario. Ontario Bur. of Mines, *Rept.*, **15** (1906).

Baker, M. B.—Clay Deposits and Works near Toronto. 12th Int. Geol. Cong., Canada, *Guide Book*, No. 6, 49–53 (1913).

Barlow, A. E.—Report on the Geology and Natural Resources of the Area Included by the Nipissing and Temiscaming Map-Sheets. Can. Geol. Surv., *Ann. Rept.*, **10**, 157 I (1899).

Bell, R.—Summary Report on the Operations of the Geological Survey for the Calendar Year 1902. Can. Geol. Surv., *Ann. Rept.*, **15**, 221A (1903); and for 1904, **16**, XXXA (1905).

Ells, R. W.—Report on the Geology and Natural Resources of the Area Included in the Map of the City of Ottawa and Vicinity. Can. Geol. Surv., *Ann. Rept.*, **12**, 48G (1901).

Ells, R. W.—Report on the Geology of a Portion of Eastern Ontario (To Accompany Map-Sheet No. 119). Can. Geol. Surv., *Ann. Rept.*, **14**, 74J (1904).

Hoffmann, G. C.—Chemical Contributions to the Geology of Canada, from the Laboratory of the Survey. Can. Geol. Surv., *Ann. Rept.*, **4**, 67R (1890); **7**, 67R (1896); **13**, 60–1R (1903).

Keele, J.—Notes on Tests of Clay Samples. Can. Geol. Surv., *Sum. Rept., 1911*, pp. 233–4 (1912).

Keele, J.—Investigation of the Clay Resources of Ontario. Can. Geol. Surv., *Sum. Rept., 1914*, p. 87 (1915).

Keele, J.—Refractory Materials in Canada. Can. Mines Branch, *Sum. Rept., 1916*, p. 111.

Keele, J.—Investigation of Clay and Shale Resources of Canada. Can. Mines Branch, *Sum. Rept., 1917*, pp. 97–120.

Keele, J.—Investigations of Clay and Shale Resources. Can. Mines Branch, *Sum. Rept., 1918*, p. 162.

Keele, J.—Mesozoic Clays in Northern Ontario. Can. Geol. Surv., *Sum. Rept., 1919, Pt. 6*, pp. 13–9 (1920).

Keele, J.—Clay and Shale Deposits of the Abitibi and Mattagami Rivers. Ont. Bur. Mines, **29** [Pt. 2], 31–55 (1920).

Keele, J.—Mesozoic Clays and Sands in N. Ontario. *Trans. Royal Soc. Can.*, Section 4, 1921.

Keele, J.—Notes on the Clays of the Missinabi River. Ont. Dept. Mines, *Ann. Rept.*, **30** [Pt. I], 171–5 (1922).

Keele, J.—Clay and Shale Deposits of Ontario. Can. Geol. Surv., *Mem.*, **142** (1924).

Lawson, A. C.—Report on the Geology of the Lake of the Woods Region. Can. Geol. Surv., *Ann. Rept.*, **1**, 149CC, 151CC (1885).

Logan, W. E.—Clays and Analyses. Can. Geol. Surv., *Prog. Rept., 1863*, pp. 641, 801, 802, 897, 915 (1863).

Ries, H.—Report on Progress of Investigations of Clay Resources. Can. Geol. Surv., *Sum. Rept., 1911*, pp. 225–9 (1912).

Romanet du Caillaud, F.—Les Roches Kaolinifères du Bassin du Lac Nèpigon (Canada). *Comptes Rend.*, **140,** 361 (1908).

Quebec

Anon.—Canadian China Clay. *British Clayworker*, **24,** 58 (1915–16).

Anon.—The Clays of Quebec. *British Clayworker*, **24,** 113 (1915–16).

Anon.—A China Clay Mine. *Can. Min. Jour.*, **43,** 523 (1922).

Anon.—China Clay in Quebec. *Can. Chem. and Met.*, **7,** 243 (1922).

Dawson, G. M.—Summary Report of the Operations of the Geological Survey for the Year 1895. Can. Geol. Surv., *Ann. Rept.*, **8,** 123A (1896).

Denis, T. C.—Notes, Analyses of the Kaolin from St. Rémi, Amherst Township. Minister Colonization and Mines, *Ann. Rept., 1915*.

Donald, J. T.—Notes on a Deposit of Clay at Côte St. Luc, Montreal, Que. *Can. Rec. Natural History*, **1,** 56–7 (1884).

Dufresne, A. O.—Brickmaking Industry in the Province of Quebec, a Review. Minister Colonization and Mines, *Ann. Rept., 1921*, p. 89–92.

Dufresne, A. O.—Notes on Brick Making at L'Islet Station. Minister Colonization and Mines, *Ann. Rept., 1921*, 65. p.

Dufresne, A. O.—Notes on Occurrences of Vitrifying Shales in the Seigniory of Lapage-Thibierge. Minister Colonization and Mines, *Ann. Rept., 1921*, p. 67.

Ells, R. W.—Report on the Geology of a Portion of the Eastern Townships Relating More Especially to the Counties of Compton, Stanstead, Beauce, Richmond and Wolfe. Can. Geol. Surv., *Ann. Rept.*, **2,** 70J (1887).

Ells, R. W.—Report on the Mineral Resources of the Province of Quebec. Can. Geol. Surv., *Ann. Rept.*, **4,** 133K (1890).

Ells, R. W.—Report on a Portion of the Province of Quebec Comprised in the South-west Sheet of the "Eastern Townships" Map (Montreal) Sheet. Can. Geol. Surv., *Ann. Rept.*, **7,** 90J (1896).

Ells, R. W.—Report on the Geology of Argenteuil, Ottawa and Part of Pontiac Counties, Province of Quebec, and Portions of Carleton, Russell and Prescott Counties, Province of

Ontario. Can. Geol. Surv., *Ann. Rept.*, **12**, 135J (1901).

Hoffmann, G. C.—Kaolinite from Acton. Geol. Surv. Canada, *Prog. Rept., 1874–75*, p. 314 (1876).

Hoffmann, G. C.—Kaolin. Geol. Surv. Can., *Rept. of Progress, 1878–79*, pp. 6–7 H (1880). (Abs., *Jour. Chem. Soc.*, **15**, 545 (1881).)

Hoffmann, G. C.—Annotated List of the Minerals Occurring in Canada. Can. Geol. Surv., *Ann. Rept.*, **4**, 41–2T (1890).

Hoffmann, G. C.—Report of the Section of Chemistry and Mineralogy. Can. Geol. Surv., *Ann. Rept.*, **8**, 14R (1897); **11**, 55R (1900); **13**, 59–60R (1903).

Keele, J.—Clay from Village of Amos, Abitibi County. Minister Colonization and Mines, *Ann. Rept., 1912*.

Keele, J.—Report on Progress of Investigation of Clay Resources. Can. Geol. Surv., *Sum. Rept., 1911*, pp. 234–9 (1912).

Keele, J.—Clay and Shale Deposits of New Brunswick. Can. Geol. Surv., *Memoir*, **14** (1914).

Keele, J.—Investigation of Clay Resources of Quebec. Can. Geol. Surv., *Sum. Rept., 1912*, pp. 351–6 (1914).

Keele, J.—Extract from Preliminary Report on Clay and Shale Deposits of Province of Quebec. Minister Colonization and Mines, *Ann. Rept., 1915*.

Keele, J.—Preliminary Report on the Clay and Shale Deposits of the Province of Quebec. Can. Dept. Mines, *Memoir*, **64**, 196 pp. (1915).

Keele, J.—Field Investigations of Clay and Shale Resources. Can. Mines Branch, *Sum. Rept., 1916*, p. 105.

Keele, J.—Kaolin in Quebec (with Discussion by H. Ries and R. R. Hice). *Jour. Amer. Ceram. Soc.*, **1**, 8–14 (1918).

Logan, W. E.—Clays and Analyses. Can. Geol. Surv., *Rept. Progress, 1863*, pp. 641, 801, 802, 897, 915 (1863).

Low, A. P.—Report on the Geology and Economic Minerals of the Southern Portion of Portneuf, Quebec, and Montmorency Counties, Province of Quebec. Can. Geol. Surv., *Ann. Rept.*, **5**, 68–9L (1892).

Ries, H.—Whiteware Materials in Ontario and Quebec, Kaolin near Huberdeau, Que. Can. Geol. Surv., *Sum. Rept., 1911*, pp. 229–32 (1912).

Selwyn, A. R. C.—Summary Report of the Operations of the Geological Survey for the Years 1884 and 1885. Can. Geol. Surv., *Ann. Rept.*, **1**, 55A (1886).

Wilson, M. E.—Description of Kaolin Deposits. Extracts from *Memoir, 113*, Can. Geol. Surv. Minister Colonization and Mines, *Ann. Rept., 1922*, p. 81.

Wilson, M. E.—Geology and Mineral Deposits of a Part of Amherst Township, Quebec. Canada Dept. of Mines, Geol. Surv., *Memoir*, **113**, 54 pp. (1919).

Saskatchewan

Anon.—Fire Clay of Saskatchewan. *Min. and Sci. Press.*, **106**, 534 (1913).

Anon.—Ceramic Deposits in Saskatchewan. *Chem. News*, **126**, 277 (1923).

Anon.—Clay Resources of Southern Saskatchewan, Canada. *Bull. of Imp. Inst.*, **21**, 505 (1923).

Chicanot, E. L.—Clay Industry in Saskatchewan. *Eng. and Min. Jour.-Press*, **116**, 107 (1923).

Davis, N. B.—Clay Resources of Southern Saskatchewan. Can. Dept. of Mines, Mines Branch, *Rept.* **468**, pp. 1–93 (1918). (Abs. in *Jour. Iron and Steel Inst.*, **98** [2], 439 (1918); abs. in *Geol. Mag.*, **6** (1919).)

Keele, J.—Report on Progress of Investigation of Clay Resources. Can. Geol. Surv., *Sum. Rept., 1911*, pp. 234–9 (1912).

Keele, J.—Refractory Materials in Can-

ada. Can. Mines Branch, *Sum. Rept., 1916*, p. 111.

Keele, J.—Clay and Shale Deposits of the Western Provinces. Part V. Can. Geol. Surv., *Memoir*, **66**, 74 pp. (1915).

Pacana, L.—Clay Deposits in Saskatchewan. *British Clayworker*, **32**, 88 (1923–24).

Ries, H.—Clay and Shale Deposits of Western Canada. Can. Geol. Surv., *Sum. Rept., 1910*, pp. 174–80 (1911).

Ries, H.—The Clay and Shale Deposits of the Western Provinces of Canada. Can. Min. Inst., *Quart. Bull.*, **16**, 11–54 (1911). (Abs., *Geol. Centralb.*, **17**, 637 (1911–12).)

Ries, H.—Report on Progress of Investigations of Clay Resources. Can. Geol. Surv., *Sum. Rept., 1911*, pp. 225–9 (1912).

Ries, H. and Keele, J.—Preliminary Report on the Clay and Shale Deposits of the Western Provinces. Can. Geol. Surv., *Memoir*, **24**, 21 pp. (1912).

Ries, H. and Keele, J.—Report on the Clay and Shale Deposits of the Western Provinces. Canada; Part II. Can. Geol. Surv., *Memoir*, **25**, 105 pp. (1913).

Rose, B.—Wood Mountain-Willowbunch Coal District. Can. Geol. Surv., *Mem.*, **89.**

Spence, H. S.—Bentonite. Can. Mines Branch, *Rept.*, **626** (1924).

Stansfield, J.—Banded Precipitates of Vivianite in a Saskatchewan Fire Clay. *Geol. Mag.*, **59** [698], 356 (1922).

Wilson, A. W. G.—Saskatchewan Clays and New Industries. *Nat. Resources of Can.*, **2**, July (1923).

MEXICO

Anon.—Análisis de arcillas del subsuelo del Palacio del Poder Legislativo Federal y del subsuelo del edificio de la Secretaría de Comunicaciones. *Parergones del Inst. Geol. de Mex.*, **5** [4], 182–7 (1913).

Anon.—Catálogo Sistemático de las Especies Minerales de México y sus aplicaciones Industriales. *Bol. del Inst. Geol. de Mex.*, No. 40 (1923).

Anon.—Catálogo Geográfico de las Especies Minerales de México. *Bol. del Inst. Geol. de Mex.*, No. 41 (1923).

Anon.—Kaolin in Mexico. *Chem. Age*, **9**, 14 (1923).

Aguilera, J. G.—Catálogo Sistemático y Geográfico de las especies minerálogicas de la República Mexicana. *Bol. del Inst. Geol. de Mex.*, No. 11 (1898).

Aguilera, J. G.—Los kaolines de la hacienda de exthō (State of Hidalgo, Mex.). Soc. Geol. Mex., *Bull.* **3**, 25–33 (1906).

Castro, C.—Análisis de una kaolinita encontrada en una muestra de carbón de Villafuente, Coahuila. *Bol. de la Sociedad Geol. Mex.*, **5**, 10, 147–50 (1908).

Del Río, A.—Las Arcillas de México. *Bol. Ofic. de la Sec. de Agricult. y Fom.*, **4**, Ser. 5a [3–4], 181–6 (1919).

Del Río, A.—Las Arcillas de México. *La Farmacia*, **IIa**, Epoca, No. 5, pp. 73–7 (1925).

Hilgard, E. W.—A Peculiar Clay from near Mexico City. *Proc. Nat. Acad. Sci.*, **2**, 8–12 (1916); *Bol. Minero*, **3** [1], 16–9 (1917).

Orvañanos, B.—Breves consideraciones para el estudio de las Arcillas que tienen aplicación entre las materiales de construcción. *Ann. del Inst. Geol. de Mex.*, No. 6 (1919).

Zárate, J. C.—Estudio y análisis de unas arcillas procedentes de la hacienda de Gloria, municipalidad de Altamira, Estado de Tamaulipas. *Bol. Minero*, **2** [3], 111–9 (1916).

Zárate, J. C.—Viaje de la isla de San Marcos a Mulegé, Boja California e Informe acerca de los Depósitos de kaolín. *Bol. de Industria Comercio y Trabajo*, **3** [3], 114–6 (1919).

SOUTH AND CENTRAL AMERICA

SOUTH AMERICA

General

Miller, B. L. and Singewald, J. T., Jr.—The Mineral Deposits of South America (1919).

Wilson, O.—Minerals, Earths and Clays of Latin America. *Chem. Met. Eng.*, **26**, 631–6, 697–700, 745–9 (1922).

Argentine

Zamboni, M. A.—The Clays of the Tandil Mts., Argentine Republic. *Anales. Soc. Quim. Argentina*, **8**, 190–9 (1920).

Brazil

Calogeras, J. P.—As minas do Brazil e sua legislação (1905), *Clays and Kaolin*, **2**, 552–6.

Derby, O. A.—On the Association of Argillaceous Rocks with Quartz Veins in the Region of Diamantina, Brazil. Description of Clay and Kaolin with Analysis by Hussak. *Amer. Jour. Sci.*, **158**, 343–56 (1899). (Analysis reprod. in Groth's *Zeits. f. Kryst. u. Min.*, **34**, 101 (1901).)

British Guiana

Anon.—Kaolin in British Guiana. *Tonind. Zeit.*, **25** [126], p. 1903 (1901).

Emory, L. T.—Bauxite Deposits of British Guiana. *Eng. Min. Jour.-Press.*, **119**, 686 (1925).

Emory, L. T.—Prospecting for Bauxite in British Guiana. *Eng. and Min. Jour. Pr.*, **119**, 45 (1924).

Harrison, J. B.—Laterites in British Guiana. *Geol. Mag.*, **7**, 439–52, 488–95, 553–62 (1910).

Chili

Anon.—Mineralojia, 3rd Ed., p. 569 (1879).

French Guiana

Fermor, L. L.—The Work of Professor La Croix on the Laterites of French Guiana. *Geol. Mag.*, **2**, 28–37, 77–82, 123–9 (1915).

Jannettaz, E.—Gibbsite et Bauxite de la Guyane Française. *Bull. de la Soc. Min. de France*, **1**, 70–1 (1879).

Meunier, S.—Sur l'existence de la Bauxite à la Guyane Française. *Comptes Rendus Acad. Sci.*, **74**, 633–4 (1872). (Abs., *Jahresbericht der Chemie*, 1099 (1872).)

WEST INDIES

Cuba

Brown, H. C.—Mineral Resources of Cuba, 1901. *Civil Report of Brig. Gen. Wood* (Military Govr. Cuba, 1902), **5** [2], 106–17 (1902).

Dominican Republic

Condit, D. D. and Ross, C. P.—A Geological Reconnaissance of the Dominican Republic. Official Publication of the Secretaryship of State of Fomento and Communications, Dominican Republic. Prepared by the U. S. Geol. Surv., *Memoirs*, **1**, 249 (1921).

Porto Rico

Gile, P. L. and Ageton, C. N.—The Red Clay Soil of Porto Rico. *Porto Rico Agr. Expt. Sta.*, **14,** 1–24 (1914).

St. Vincent

Anon.—The Kaolin of St. Vincent. *British Clayworker,* **12,** 81 (1903–04).

Anon.—Kaolin from St. Vincent. Imp. Inst., *Bull.* **1,** 19–20 (1903).

EUROPE

Austria

Anon.—Die Kaolingruben im Vincentischen. *Oesterr. Zeits. f. Berg.-u. Hüttw.,* **69,** 217 (1901).

Anon.—Austrian Kaolin. *British Clayworker,* **30,** 247 (1921–22).

Helmhacker, R.—Bauxite in Austria. *Eng. Min. Jour.,* **66,** 457 (1898).

Knaffl, L.—Untersuchung der in Oesterreich Vorkommenden und zur Erzeugung Feuerfester Materialien Benutzten Thone und Kaolinerden. *Dingler's Polytech. Jour.,* **174,** 292.

Kovář, F.—Chemische Untersuchung von fünf Mineralien aus Mähren. (Analysis of Kaolin.) (Extr. from *Abhandl. d. böhm Akad.,* **15** [1], p. 18, böhm.) Groth's *Zeits. f. Krystallog. u. Min.,* **31,** 524 (1899).

Kovář, J.—Chemische Untersuchung einiger Mineralien von Vicz bei Bistritz am Bernstein in Mähren (Analysis of Kaolin.) (Extr. from *Chemische Blätter,* 1899. Böhmisch.) Groth's *Zeits. f. Krystallog. u. Min.,* **34,** 706–7 (1901).

Lipold.—Kaolin von St. Martin im Bacher Gebirge in Steiermark. *Jahrb. Geol. Reichsanstalt,* **9,** 46.

Ries, H.—Kaolins and Fire Clays of Europe. U. S. Geol. Surv., *19th Ann. Rept., Pt. VI (cont.),* pp. 435–45 (1897–98).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.),* p. 372 (1901).

Schneider, L.—Zusammensetzung von Bauxit von Krain. *Dingler's Polytech. Jour.,* **224,** 334.

Van der Leeden, R.—Über ein durch atmosphärische Verwitterung enstandenes Kaolin vorkommen bei Schwanberg in Steiermark. *Centralblatt für Mineralogie, Geologie und Paläontologie,* pp. 489–92 (1910).

Weithofer, A.—Occurrence of Fire Clay in the Kladno Coalfield. Verhandlungen des Naturf. *Vereins. Brünn.,* **43,** 44. (Abs. in *Jour. Iron and Steel Inst.,* **69** [1], 319 (1906).)

Belgium

Anon.—Technical Excursion in the North and in Belgium. *Ceramique,* **25,** 193–7, 241–51 (1922).

Asselberghs, E.—Kaolin of Belgium. *Ann. Mines. Belg.,* **21,** 1059–67 (1920). (Abs., *Rev. Geol.,* **1,** 292–3 (1920).)

Jérdine, A.—Discovery of a Notable Deposit of Kaolin in Ardenne. *Bull. Soc. Belg. Geol.,* **21,** 217–22 (1908).

de Koninck.—Über den Kaolinite von Quenast und aus der Steinkohlenformation. Recherches sur les minéraux Belges IV., *Bull. Acad. Belg.,* **44** [12], 2 (1877).

Ries, H.—Kaolins and Fire Clays of Europe. U. S. Geol. Surv., *19th Ann. Rept., Pt. VI,* p. 55 (1898).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.),* p. 372, 373 (1901).

Simoens, G.—Observations faites au gisement Kaolinifère de Lebin. *Bull. Soc. Belg. Géol., Brux.,* **21,** 1907 (1908), Proc. verb., pp. 222–4.

Bosnia

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 373 (1901).

Bulgaria

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 373 (1901).

Czechoslovakia

Anon.—The Bunz Clays. *Tonind. Zeit.*, **33,** 763–5 (1919).

Bauer, A.—Analyse eines Kaolins von Zettlitz bei Karlsbad. *Sitzungsber, k. Akad. Wiss.*, **22,** 693. (Abs., *Neues Jahrb. für Mineral.*, p. 569 (1858).)

Burian, J.—Technical Study of Bohemian Clays. *Chem. Listy*, **6,** 62–4.

E. H.—Ceramic and Paper Kaolin. *Tonind. Zeit.*, **44,** 439 (1920).

Gabert, C.—Neue Aufschlüsse in Böhmischen Kaolinlagerstätten. *Zeits. f. Prakt. Geol.*, **17,** 142 (1909).

Haskovec, A.—Keramické suroviny okolí Bechyně. *Časopis pro průmysl chemický*, 116–8 (1900). (Abs., *Geol. Centralb.*, **1,** 616 (1901).)

Hochstetter, F. v.—Karlsbad, seine geognostischen Verhältnisse und seine Quellen (1856); also *Sitzungsber. k. Akad. Wiss.*, **20,** 13 (1856).

Hoff, v. K. E. A.—Geognostische Bemerkungen über Karlsbad. *Gotha* (1825).

Jokély, I.—Zur Kenntniss der geologischen Beschaffenheit des Egerer Kreises. *Jahrb. geol. Reichsanst.*, **7,** 479 (1856) and **8,** 1 (1857).

Kanka, A.—Refractory Clays in Mahr Truban, Czechoslovakia. *Montan. Rundschau.* **16,** 81–7 (1924).

Katzer.—Geologie von Böhmen.

Kovář, F.—Analysen einiger Mineralien aus den Graphitbergwerken bei Malý Tresný in Mähren. (Kaolin.) *Časopis pro prům. Ysl. chemický*, 1898.

Kovář, F. and Haskovec, A.—Über zwei feuerfeste Thone von Vranavá bei Křetin in Mähren. *Zeits. für chem. Industrie*, 3 p. (1899).

Laube, G. C.—Geologie des böhmischen Erzgebirges, 1st Theil. *Archiv. d. naturw. Com.*, 1876.

Laube, G. C.—Geologische Excursionen im böhmischen Thermalgebiet. (1884)

Löwl, F.—Die Verbindung des Kaiserwalds mit dem Erzgebirge. *Jahrb. geol. Reichsanst.*, **31,** 454 (1881).

Purkyně, C. v.—Kaolin v. kamenouhelné páuvi Plzenské. *Časopis pro průmysl chemický* (1901). (Abs. in *Geol. Centralb.*, **2,** 780 (1902).)

Purkyně, C.—Ložiska kaolinová v. Plzeňsku (Kaolin deposits at Pilsen). *Mit 1 Abbild. Vesmir, Prag,* **31,** No. 7 (1902). (Abs., *Geog. Centralb.*, **3,** 145 (1903).)

Safarik.—Über böhmische Kaoline. *Sitzungsber. d. K. böhm. Ges. d. Wissensch.*, **16,** Feb. (1870).

Watts, A. S.—Clay and Kaolin Mining in Europe. *Trans. Amer. Ceram. Soc.*, **13,** 232 (1911).

Denmark

Anon.—British China Clay in Denmark. *The British Clayworker*, **28,** 220 (1919–20).

Braun.—Über die Morphologie von Bornholm. *Jahresber. d. Geogr. Ges.*, **9,** 163–200 (1908).

Cohen, E. and Deecke, W.—Über das krystalline Grundgebirge der Insel Bornholm. *Jahresber. geol. Ges.*, **6,** (1889).

Elssing, N. V.—Kaolin on Island of Bornholm. *Danm. Geol. Unders. II, R. 1 Yr.*, **12,** 60 (1902).

Forchhammer, G.—Oversigt over Dan-

marks geogn. Bygning. *Förhandl. vid Skand. Naturforsk. Möte Stockholm*, p. 29.

Forchammer, G.—Om dë Bornholmske Kulformationer. *Vidensk. Selsk. naturvid. och mathem. Afhandl.*, **7**, 18 (1837).

Jacobsen, C.—Ceramic Industry. *Trans. Eng. Ceram. Soc.*, **22**, 20 (1922–23). (Abs., *Jour. Amer. Ceram. Soc.*, **7**, 28 (1924).)

Johnstrup, F.—Abriss der Geologie von Bornholm, als Führer zu der Excursion der deutschen geologischen Gesellschaft, p. 10 (1889).

Richards, J. W.—Danish Clay. *Electrochem. and Metal. Ind.*, **7**, 474–5. (Abs. in *Jour. Iron and Steel*, **81** [1], 558 (1910).)

Ries, H.—Clayworking in Denmark. *The Clayworker*, **29**, 498 (1898).

Ries, H.—Kaolins and Fire Clays of Europe. U. S. Geol. Surv., *19th Ann. Rept., Pt. VI (cont.)*, 445–8 (1897–98).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 374 (1901).

Rordam, K.—Undersøgelse af Mesozoiske Lerarter og Kaolin paa Bornholm i geologisk og teknisk. Henseende. *Dan. geol. Undersøg.*, Ser. II, pp. 1–109 (1890).

Seger, H.—Die Thonindustrie auf der Insel Bornholm. *Gesammelte Schriften*, p. 477.

Winkel, H. E.—Kaolinslemmeriet "Rabekkegaard" poa Bornholm. *Kjöbenhavn Tekn. Forenings Tidsskrift* (1885).

Elba

Brogniart, A.—Über Porcellanerde, etc. *Bull. soc. geol. France*, **10**, 56 (1839); *Compt. rend.*, **7**, 1085; *Jour. prakt. Chem.*, **17**, 118 (1839); *Archiv. d'mus. d'hist. nat.*, **8**, 446 (1840).

Finland

Aarnio, B.—Lerornas konsistense genskaper. Hygroskopiciteten has gelerna Fe_2O_3, Al_2O_3 och SiO_2, vid olika temperaturer. *Geologiska kom., Geotekniska meddelanden*, Nos. 24 and 25.

Anon.—China Clay in Finland. *The British Clayworker*, **30**, 215 (1921–22).

Frosterus, B.—Bildrag till kännedomen om våra lerors tekniska egenskaper. *Geologiska kom., Geotekniska meddelanden*, No. 1.

Frosterus, B.—Det finska lermaterialet som geologisk bildning och teknisk produkt. *Geologiska kom., Geotekniska meddelanden*, No. 6 (1909). (Abs., *Geol. Centralbl.*, **15**, 71 (1910–11).)

Frosterus, B.—Lertekniska studier: Vattenhalten i våra tegelleror. Försökatt genom tillblandningar höja smältpunkten hos finsk lera. *Geologiska kom., Geotekniska meddelanden*, No. 9.

Frosterus, B. and Glinka, K.—Zur Frage nach der Einteilung der Böden in Nordwest-Europas Moränengebieten. *Geologiska kom., Geotekniska meddelanden*, No. 11., Pts. I and II.

Frosterus, B.—Zur Frage nach der Einteilung der Böden in Nordwest-Europas Moränengebieten. *Geologiska kom., Geotekniska meddelanden*, No. 13, Pt. IV and No. 14, Pt. V.

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 375 (1901).

Sederholm, J. J.—Om de Tekniska egenskaperna has finska granites. *Geologiska kom., Geotekniska meddelanden*, No. 8.

Väyrynen, H.—The Geological Relations of an Occurrence of Kaolin in the Finnish Grundgebirge. *Geol. För. Förh*, **46**, 393–406 (1924).

France

Anon.—Bauxite in France. *Eng. and Min. Jour.*, **74**, 242 (1902).

Anon.—A French Kaolin Deposit. *Moniteur de la Céramique.* (Abs. in *British Clayworker*, **11**, 93 (1902–03).)

Anon.—Visit to the Kaolin Quarries of the Region d'Echassières, Allier. *Rev. Mat. Constr. Trav. Pub.*, **181**, 220–7B (1924).

Alluand.—Rapport sur les Grès Molasses ou Granits Arénacés Kaoliniques de Degnac (1832).

Augé.—Note sur la Bauxite, son Origine son Âge et son Importance Géologique. *Bull. Soc. Geól., France*, 3rd Ser., **16**, 345 (1888).

Auscher.—Les Céramiques Cuisant á Haute Température (Kaolins.) p. 21.

Auscher and Quillard.—Technologie de Céramique. (Kaolins.) p. 23 (1901).

Baret.—Sur une Argile de la Carrière du Rocher-d'Enfer sur les Bords de l'Erdre près Nantes. *Bull. Soc. Minéral, France*, **7**, 118–20 (1885). (Abs. in *Jahrbuch für Mineral.*, **2**, 35 (1887).)

Baud, E.—Industrie et Analyse de la Bauxite. *Rev. Gén. de Chimie*, **6**, 368–71 (1903).

Becquerel.—De l'Argile plastique d'Autenil, et des Substances qui l'Accompagnent. *Ann. de Chim. et de Physique*, p. 348 (1823). (Abs. in *Bull. Gén. et Univ. des Annonces*, **7**, pp. 40–1 (1823).)

Berthier, P.—Analyse de l'Alumine Hydratée des Beaux, Départment des Bouches-du-Rhône. *Annales des Mines*, Ser. 2, **6**, 531 (1821).

Berthier, P.—Über Kaolin und einige Thonarten. *Annal. chim. phys.*, **60** (1836); *Jour. für prakt. Chemie*, **10**, 28 (1837).

Berthier, P.—Sur le Kaolin et sur les Argiles. *Annales de Chimie et de Physique*, **62**, 225–42 (1836); also *Jour. für prakt. Chemie*, **10**, 28–41 (1837).

Bougerel, G. L.—Constitution et Formation des Bauxites. *Moniteur Scientifique*, **51**, 21–2 (1898).

Brongniart, A.—Premier mêmoire sur les kaolins, ou argiles à porcelaine, sur la matière, le gisement, l'origine et l'emploi des cette sort d'argile. Extr. *Archives du Musée d'Hist. Nat.*, **1**, 243–302 (1839).

Brongniart, A.—Über Porcellanerde, etc. *Bull. soc. géol. France*, **10**, p. 56 (1839); *Compt. Rend.*, **7**, 1085; *Jour. prakt. Chemie.*, **17**, 118 (1839); *Archiv. d. Musée d'Hist. Nat.*, **8**, 446 (1840).

Brongniart, A., and Malaguti.—Second mémoire sur les kaoline, ou argile à porcelaine. *Compt. Rend.*, **13**, 735–54 (1841). *Archives Muséum d'Hist. Nat.*, **2**, 217–305 (1841); *Jour. für Prakt. Chemie*, **31**, 129–60 (1844); *Annales des mines*, 4th Ser., **2**, 465–74 (1842).

Burat, A.—Minéralogie appliquée. Description des Minéraux Employés dans les Industries, etc. (Argiles, Kaolins, Analysis.) Pp. 260–9 (1864).

Caumont, M. de.—Note sur le Kaolin du Départment de la Manche. *Mém. de la Soc. Linnéenne de Normandie* (1826–27). (Abs. in *Bull. Sci. Nat. et de Géol.*, **10**, pp. 253–54 (1828).)

Charpentier, H.—Geologie et Minéralogie Appliquées. Les Minéraux et leur Gisements. L'Alumine et ses Composés; Alum, Argiles, Kaolin, pp. 532–8 (1900).

Collot, L.—Âge des Bauxites du sud-est de la France. *Bull. Soc. Géol. France*, 3rd Ser., **15**, 331–45. (Abs. in *Trans. North of Eng. Inst. Min. Eng.*, **37**, 4 (1888).)

Collot, L.—Sur la Bauxite d'Allières. Description Géologique des Environs d'Aix en Provence. (Bauxite.) p. 84 (1880).

Collot, L.—Âge de la Bauxite dans le sud-est de la France. *Compt. Rend.*, **104**, 127–30 (1887).

Coquand.—Sur les Bauxites de la Chaîne

des Alpines (Bouches-dur-Rhône) et leur Âge Géologique. *Bull. Soc. Géol. France,* 2nd Ser., **28,** 98–115 (1870–71).

Coudroy, G. du.—Notice sur les Argiles Kaolinique de Gaudry (Nièvre). *Bull. Soc. Hist. Nat.,* **12,** p. 2, 277. (Abs., *Geol. Centralb.,* p. 675 (1901).)

Curioni.—Analyses of Two Kaolins from Lombardy. *Ann. des Mines,* Ser. 7, **13,** 364 (1878).

Damour.—Notice et Analyses sur un Kaolin Produit par la Décomposition du Béryl. *Bull. Soc. Géol. France,* 2nd Ser., **7,** 224–31 (1849–50).

Damour, A.—Argile Rose des Environs de Nantes. *Bull. Soc. Min. de France,* **13,** pp. 305–6 (1885).

D'Aoust, V.—Sur le Mineral Fer Alumineux Pisolithique de Mouriès, et aussi des Baux. *Bull. Soc. Géol. France,* 2nd Ser., **22,** 418–20 (1864–65).

Daubrée, A.—Sur l'Existence de Gisements de Bauxite dans les Départments de l'Hérault et de l'Ariége. *Bull. Soc. Géol. France,* 2nd Ser., **26,** 915–8 (1868–69).

Daubrée, A.—Note sur le Kaolin de la Lizelle, etc. *Comptes Rendus Acad. Sci. Paris,* **68** 1135–9 (1869).

Daubrée, A.—Note sur un Silicate Alumineux Hydraté, Déposé par la source Thermale de Saint-Honoré (Nièvre) depuis l'Époque Romaine. *Comptes Rendus Acad. Sci. Paris,* **83,** 421 (1876).

Daubrée, A.—Les Eaux Souterraines aux Époques Anciennes (1887). (Kaolin, pp. 178–80, 313; Bauxite, pp. 95–97.)

Delesse, A.—La Formation du Granite en Arène et en Kaolin. *Bull. Soc. Géol. France,* 2nd Ser., **10,** 256–64 (1852–53).

Delesse, A.—Remarques sur le Granite et sur les Roches Métamorphiques. *Bull. Soc. Géol. France,* 3rd Ser., **3,** 154–60 (1875).

Diday.—Analyse de Kaolin de Grimaud (Départ. Var.). *Ann. des Mines,* Ser. 3, **18,** 725–6 (1840).

Dieulafait.—Les Bauxites, Leurs Âges, Leur Origine. *Comptes Rendus Acad. Sci. Paris,* **93,** 804–7 (1881).

Dieulafait.—Origin of Phosphorites and Ferruginous Clays in Limestone Districts. *Jour. Chem. Soc. (Abstracts),* **46,** 1272 (1884).

Durand-Claye.—Kaolin de Gavaudun, Lot-et-Garonne. *Ann. des Mines,* Ser. 7, **13,** 364 (1878).

Fournet, J.—Mémoire sur la decomposition des Minéraux d'Origine Ignée et leur Conversion en Kaolin. *Annales de Chimie et de Phys.,* **55,** 226–56 (1834). (Abs. *Neues Jahrbuch für Mineral,* pp. 85–8 (1836).)

Fuchs and de Launay.—Traité des Gîtes Minéraux (1893).

Gasparin, P. de.—Sur la Constitution des Argiles. *Comptes Rendus Acad. Sci.,* **74,** 1180 (1872). (Abs. *Chem. News,* **25,** 275 (1872).)

Gourret, P. and Gabriel, A.—La Bauxite et les Étages qui la Recouvrent dans le Massif de Garlaban. *Comptes Rendus,* **106,** 1551–3 (1889).

Granger, A.—Sur la Composition des Argiles, d'après M. Vogt. *Moniteur Scientifique,* **50,** 798–806 (1897).

Griffin, W. T.—The Treatment of Kaolin at Limoges. Quoted in *Eng. and Min. Jour.,* **64,** 401 (1897).

Gruner, L.—Observations sur les Minerai de Fer en Grains ou Minerai Pisiforme. (Origin of Bauxite.) *Bull. Soc. Géol. France,* **23,** 2nd Ser., pp. 200–5 (1870–71).

Guillemin.—Pholerit from Fins (Allier.) *Annal. de Min.,* **11,** 489 (1825).

Hébert, E.—Observations sur l'Argile Plastique, et les Assise qui l'Accompagnent dans la Partie Méridionale du Bassin de Paris. 24 pp. (1854).

Hinstin.—Notice sur les Kaolins de l'Allier et les Blanc de Meudon. *Bibliothèque de l'École des Mines de Paris* (1889).

Jannettaz, E.—La Composition d'un Variété Pisolithique de Bauxite.

Bull. Soc. Géol. France, **6**, 392 (1877–78).

Jerome, A. and Simoens, G.—De la Découverte d'un Gisement de Kaolin en Ardenne. *Bull. Soc. Belge Geol., Brux*, **21** (1907), *Procès verb.*, pp. 217–22.

Körner, J. A.—Beitrag zur Kenntnis der Elsässer Thone. *Inaug.-Diss.*, Erlangen (1900).

Lacvivier, M. de.—Etudés Géologiques sur l'Ariège. (Bauxite, p. 90.)

Lacroix, A.—Minéralogie de la France, **1** (1893).

Lapparent, A. de.—Kaolins du Lot-et-Garonne de Lombardie, de Thuringe; Kaolinisation. Revue de Géologie, *Ann. des Mines*, 7th Ser., **13**, 364 (1877).

Lapparent, A. de.—Traité de Geologie. Kaolin, Argiles Refractaires, Bauxite, pp. 1388–9, 2nd ed. (1885).

Launay, L. de.—Note sur les Gisements de Kaolin de la Forêt des Colettes (Allier). *Bull. Soc. Géol. de France*, Ser. 3, **16**, pp. 1065–72 (1887–88).

Launay, L. de.—Les Kaolins de l'Allier *La Nature*, **1446**, 161–3; (Abs. *Geol. Centralb.*, **1**, 583 (1901).)

Launay, L. de.—Excursion à quelques Gîtes Minéraux et Métallifères du Plateau Central. Extr. du *Compt. Rend.*, **8**, Congrès Géologique International, 1900, Paris, 1901. (Carrières de Kaolin des Colettes (Allier), pp. 18–20.)

Launay, L. de.—Observations sur les Kaolins de St. Yrieux. *Ann. des Mines*, **3**, 5–49 (1903).

Launay, L. de.—Traité de Métallogénie, Gîtes Minéraux et Métallifères, **1**, 802–15 (1913).

Laur, F.—Les Bauxites. *Bull. Soc. Ind. Min.*, 3d Ser., **8**, 513–26 (1894).

Lavezard, E.—Contribution à l'Étude des Argiles de France. *Trans. Inst. Min. Eng.*, **36** (1908–09).

Lavezard, E.—Contribution à l'Étude des Argiles de France. Mem. Publiés par la Société d'Encouragement pour l'Industrie Nationale, p. 113 (1906).

Lavezard, M. E.—Étude sur l'Argile. *Bull. Soc. d'Encour.*, **106**, 65–7 (1904).

Laville, M.—Étude géologique sur les Gisements des Argiles de France. *Mem. Soc. d'Encouragement pour l'Industrie Nationale* (1906).

LeChatelier, H.—Sur la Constitution des Argiles. *Comptes Rendus Acad. Sci., Paris*, **104**, 1517–20 (1887); *Bull. Soc. Chemique*, **48**, 116–24 (1887); Abs. in *Berichte*, **20**, 454 (1887); *Jour. Chem. Soc., London*, **52**, 785 (1887); *Chemical News* **55**, 309 (1887); *Zeits. phys. Chemie*, **1**, 398–402 (1887).

Lefort.—Sur la formation du Kaolin (Rhétien) dans la Nièvre (1884).

Linau, H.—Analysen Französischer Bauxite. *Chemiker Zeits.*, **27**, 422–4 (1903).

Meunier, S.—Sur l'Origine et le Mode de Formation de la Bauxite et du Fer en Grains. *Comptes Rendus Acad. Sci. Paris*, **96**, 1737 (1883).

Meunier, S.—Réponse à des observations de M. Augé et de M. A. de Grossouvre sur l'Histoire de la Bauxite et des Minerais Siderolithiques. *Bull. Soc. Géol. France*, Ser. 3, **17**, 64–7 (1889).

Meunier, S.—Origine de l'Argile à Silex. *Bull. Soc. Géol. de France*, Ser. 4, **1**, 197–8 (1901).

Ries, H.—Kaolins and Fire Clays of Europe. U. S. Geol. Surv., *19th Ann. Rept., Pt. VI (cont.)*, 401–2 (1897–98).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, 375–82 (1901).

Roule, L.—Sur les Gisements et l'Âge de la Bauxite dans le sud-est de la France. *Comptes Rendus*, **104**, 383–5 (1887).

Schmidt, C. and Hinden, F.—Geological and Chemical Investigation of the Clay Deposits at Alsace and at Allschwyl near Basle. *Zeits. prakt. Geol.*, **15**, 46–56 (1907).

Seger, H.—Über einige Rohmaterialien

der Porcellanfabrikation in Limoges. *Ges. Schriften*, p. 550.

Thurmann, J.—Essai de Phytostatique, etc. 1850 (Kaolin).

Vogt, G.—Clays of France. *Bull. Société d'Encouragement* **103,** pp. 937–40. (Abs. in *Jour. Iron and Steel Inst.*, **67** [1], 560 (1905).)

Watts, A. S.—Clay and Kaolin Mining in Europe. *Trans. Amer. Ceram. Soc.*, **13,** 234 (1911).

Germany

Ahrens, B.—Der rote Kaolin von Kreisau in Schlesien. *Chem. Zeit.*, **2,** 716 (1903).

Ammon, v. L.—Die Malgersdorfer Weisserde. *Geognost. Jahreshefte*, **13,** 195–208 (1900). (Abs., *Geol. Centralb.*, **2,** 164 (1902).)

Anon.—Thonanalysen. *Dingler's Polytech. Jour.*, **229,** 451–5 (1878).

Anon.—Über feuerfeste Materialien. *Berg.-unt Hüttenmännische Zeitung*, **45** [36], 381 (1886); **45** [37], 392–4 (1886).

Anon.—Neu entdeckte Kaolinlager. *D. Töpfer-u. Ziegler-Ztg.* (1910). (Abs. *Geol. Centralb.*, **17,** 637 (1911–12).)

Anon.—Clay and Kaolin Works in Saxony. *Tonind. Ztg.*, **44,** 1062 (1920).

Anon.—The Clay and Kaolin Works of Saxony. *Tonind. Ztg.*, **46,** 599 (1922).

Backofen and Stremme.—Das Verhalten des Teplitzer Quarzporphyres unter dem Moor bei Zinnwald. *Sprechsaal* (1911).

Barnitzke, J. E.—Über das Vorkommen der Porzellanerde bei Meissen und Halle A. S. *Zeits. f. prakt. Geol.*, **17,** 457–73 (1909).

Bischof, C.—Pyrotechnische Werthbestimmung des Bekannten Selingenberger Thones, Sorte I und II, im Vergleiche zu einander. *Dingler's Polytech. Jour.*, **174,** 49–53 (1864).

Bischof, C.—Pyrotechnische Werthbestimmung des Thones von Schwarzenfeld bei Schwamdorf in Bayern und des in Verbindung damit Benutzten Sandes aus dem Flusse Naab, Nebst Chemischen Analyse des Ersteren. *Dingler's Polytech. Jour.*, **175,** 447–51 (1865), and *Jahresbericht der Chemie für, 1865*, p. 800.

Bischof, C.—Analyse nebst Pyrometrischer Werthbestimmung Zweier im Handel vorzugsweise Bekannten, rheinischen feuerfesten Thone. *Dingler's Polytech. Jour.*, **183,** 29–34 (1867).

Bischof, C.—Analyse nebst Pyrometrischer Werthbestimmung des bekannten und zu Glashäfen vorzüglich gesuchten feuerfesten Thones von Grünstadt. *Dingler's Polytech. Jour.*, **135,** 39–42 (1867).

Bischof, C.—Werthstellung verschiedener Kaoline untersich durch Pyrometrische Bestimmung. *Dingler's Polytech. Jour.*, **198,** 396–413 (1870). (Abs. *Quart, Jour. Chem. Soc.*, **9,** 40 (1871).)

Bischof, C.—Pyrometrische Werthbestimmung eines bei Strehlen in Schlesien Aufgefundenen Kaolins, nebst Chemischer Analyse des durch Schlämmen daraus gewonnenen Materials. *Dingler's Polytech. Jour.*, **199,** 307–10 (1871).

Bischof, C.—Pyrometrische Untersuchung des bekannten ausgezeichneten Thonworkommens bei Eisenberg. *Deutsch Ind. Zeitung*, p. 333 (1871). (Abs., *Chem. Centralb.*, p. 719 (1871).)

Bischof, C.—Versuch einer Zusammenstellung der Deutschen und der Bekanntesten Fremden Thone nach den Formationen, etc. *Dingler's Polytech. Jour.*, **206,** 295–303 (1872).

Bischof, C.—Pyrometrische und Analytischen Untersuchung eines gelben und rothen Ziegellehmes. *Dingler's Polytech. Jour.*, **211,** 128–33 (1874).

Bischof, C.—Neues Kaolinvorkommen bei Göppersdorf, dessen Pyrometrisches Verhalten, nebst chemischer Analyse des Rohen wie Geschläm-

ten Materials. *Dingler's Polytech. Jour.*, **213**, 60–3 (1875). (Abs. *Quart. Chem. Soc.*, **13**, 433–4 (1875).)

Bischof, C.—Untersuchung von zwei zu Znaim (Mähren) Vorkommenden Kaolinen. *Dingler's Polytech. Jour.*, **214**, 434–8 (1877).

Bischof, C.—Analyses of Bauxite. *The Metallurgical Review*, **2**, 523 (1878). (Abs. from *Berg.-und Hüttenmännische Zeitung*, p. 196 (1878).)

Bischof, C.—Die Thone aus Bayern. (1883).

Bischof, C.—Fire Clay from Wildstein. *Sprechsaal*, **25**, 193; *Jour. Iron and Steel Inst.*, **2**, 343 (1892).

Bischof, C.—Gesammelte Analysen der in der Tonindustrie Benutzten Mineralien (1901).

Bischof, C.—Die feuerfesten Tone. 4th Ed. (1923).

Bley, L. F.—Chemische Untersuchung einer Porcellanerde von dem Gute Gutenberg unweit Halle a. S. *Jour. prakt. Chemie*, **5**, 313 (1885).

Blomstrand, C. W.—Zur Frage über die Hainstädter Thone. *Jour. für prakt. Chemie*, **33** [2], 483–8 (1886). (Abs. in *Berichte*, **19**, 389 (1886).)

Blum.—Pseudomorphosen, a. Hauptband, 1843. (Kaolin, Passau.) *Nachtrag*, **1** (1847); **2** (1852); **3** (1863); **4** (1879).

v. **Braunmühl.**—Mitteilungen über den Neuroder Schieferton. *Ber. über die 31, ord. Hauptvers. d. V. deutscher Fabriken feuerfester Produkte*, 71–80 (1911). (Abs., *Geol. Centralb.*, **16**, 668 (1911).)

Brongniart, A.—Über Porcellanerde, etc. (Kaolin in Saxony). *Bull. Soc. Geol. France*, **10**, 56 (1839); *Comptes Rendus*, **7**, 1085; *Jour. Prakt. Chemie*, **17**, 118 (1839); *Archiv. d. mus. d' Hist. Nat.*, **8**, 446 (1840).

Brongniart, A.—Zweite Denkschrift über die Kaoline oder Porzellanerden, über die Natur und den Ursprung derselben. *Poggendorff. Annalen*, **60**, 129 (1843).

Bruhns.—Die Nutzbaren Mineralien und Gebirgsarten im Deutschen Reiche (1906).

Clark, W. S.—Analyse von Kaolin von Schneckenstein. *Annal. Chem. Pharm.*, **80**, 122 (1851) and *Jahresber. Chem.*, p. 786 (1851).

Cobenzi, A.—A Noteworthy Deposit of Kaolin at Neckarsteinach. *Chem. Zeit.*, **46**, 334–5 (1922); *Keram. Runds.* **30**, 202 (1922).

Cramer, E.—Feuerfeste Thone und Quartzite. *Chemiker Zeit.*, **25**, 201–2 (1901).

Credner, G. R.—Die Krystallinischen Gemengtheile gewisser Schieferthone und Thone. *Zeitschr. für gesam. Naturwiss.* (Abs., *Jahrbuch für Mineral*, pp. 423–4 (1875).)

Dalmer, K.—Erlaüterungen zur geologischen Specialkarte des Königreichs Sachsen. Section Schneeberg (6).

Dammer, B.—Beitrage zur Kenntnis einiger Kaolinlagerstätten. *Zeit. f. prakt. Geol.*, **11**, 357–8 (1903). (Abs., *Geol. Centralb.*, **6**, 269 (1905).)

Drechsler, E.—Analyse des Bauxites aus des Wochein. *Dingler's Polytech. Jour.*, **203**, 479–81 (1872).

Ebermayer.—Über feuerfesten Thon und Sand aus der Keuper-Formation bei Coburg. *Berg. und Hüttenmännische Zeit.*, **20**, 209 (1861).

Ehrenberg, C. G.—(Kaolin at Aue, Saxony.) In paper on: Über die organischen Formen Gewisser. *Mineralien. Berlin Akad.*, **18**, Aug. (1836).

Endell, K.—Über die Entstehung der Porzellanerde aus basischen Eruptivgesteinen. *Sprechsaal*, **43**, 278–80. (Abs., *Geol. Centralb.*, **17**, 586 (1911–12).)

Fiebelkorn, M.—Geologische Ausflüge in die Umgegend von Berlin (1896).

Fiebelkorn, M.—Die Entstehung unserer Thongesteine (Aus "Baumaterialienkunde"), 39 pp. (1900).

Fiebelkorn, M.—Die Tone des norddeutschen Flachlandes und ihre Verarbeitung, mit besondere Berücksichtigung der Herstellung und Ver-

wendung von Portlandzement. *Brandenburgia,* **12** [7], 237–57 (1903). (Abs., *Geol. Centralb.,* **13,** 509 (1909–10).)

v. **Flurl.**—Kaolin at Passau. *S. Köhler's Bergmänn Journal,* **2,** 532 (1790).

Freise, F.—Clays of the Westerwald. *Zeits. für prakt. Geologie,* **16,** 162–5. (Abs. in *Jour. Iron and Steel Inst.,* **76** [1], 251 (1908).)

Freiesleben.—Kaolin at Aue, Saxony. *Geognost. Arbeiten, Magaz. f. Oryktographie von Sachsen,* **1,** 83 (1830).

Fresenius, R.—Chemische Untersuchung einiger der Wichtigsten Nassauischen Thone. *Jour. für prakt. Chemie,* **57,** 65–80 (1852).

Fuchs, J. N.—Über die Entstehung der Porzellanerde Mineralogisches Taschenbuch für Jahr 1823. Von Karl C. R. von Leonhard, **17,** I, Abth., 94–128 (1823).

Gehler, A. F.—Kaolin near Passau. *Schweigger's Jour. f. Chemie und Physik.* **1,** 447 (1811).

Gehler, A. F.—Kaolin near Passau. *Moll's Ephem. d. Berg. und Hüttenk.* **2,** 321.

Gehler, A. F.—Über das Vorkommen u. die Gewinnung der Porcellanerde im ehemaligen Furstenthum Passau, 1811.

Gericke, C.—Über die Gaugthonschiefer in den Erzgäugen des Nordwestlichen Aberharzes. (Inaugural-Dissertation an der Universität Göttingen.) (Analyses of Clay Shales) (1868).

Glocker, E. F.—Kaolin in Mähren. Mineralogisches aus Schlesien und Mähren. *Isis,* **23,** 1084 (1830).

Groddeck, A. von.—Studien über Thonschiefer, Gangthonschiefe und Sericitschiefe (Clay Slate and Sericite Slate). *Jahrbuch k. preuss. Geol. Landesanstalt für, 1885,* 1–52. (Abs. in *Jahrbuch für Mineral,* **1,** 415–7 (1888).) (Abs. in *Jour. Chem. Soc.,* **54,** 795 (1888).)

Gümbel, C. W.—Verzeichnis der in der Oberpfalz vorkommenden Mineralien Korrespondenzbl. *Zoöl. Min. Ver. Regensburg,* **7,** 151 (1853).

Gümbel, C. W.—Nakrit aus dem Kohlengebirge der Rheinpfalz. *Neues Jahrb.,* p. 385 (1878).

Häberle, D.—Die Tonlager der Rheinpfalz und ihre Industrie. *Der Steinbruch,* 1918 u. 1919, **13** u. **14,** Jahrg., No. 47–52 u. No. 1–2; also *Mitt. u. Arbeiten a. d. Geologischen Institute der Univ. Heidelberg, N. F.* No 33. *Berlin, Union Deutsche Verlagsgesellschaft,* 1919. (Abs., *Geol. Centralb.,* **24,** 69 (1919–20).)

Häberle, D.—Die keramische Industrie der Rheinpfalz. *Bayerischer Heimatschutz,* 17, Jahrg., 1919 (auch Bayerischer Heimgarten 1919–20), 36–41. (Abs. *Geol. Centralb.,* **24,** 172 (1919–20).)

Hauer, K. R. von.—Arbeiten, Ausgeführt im Chemischen Laboratorium der k. k. Reischsanstalt. *Jahrbuch* (Fire Clay), **11,** 285 (1860); (Clay, Kaolin, Feldspar), **13,** 147, 148, 475 (1863); (Clay Analyses), **14,** 139 (1864); (Kaolin), **14,** 304 (1864).

Hauer, K. R. von.—Kaolin and Clay Analyses. *Jahrbuch k. k. Geol. Reichsanstalt,* **9,** 172, 696 (1858), **11,** 285 (1860); **13,** 147–8 (1863); **14,** 139, 304 (1864); **19,** 428, 430, 433 (1869).

Hauer, K. R. von.—Kaolin von Budweis, Feuerfester Thon von Rév., etc. Porcellanerde. (Analyses.) *Jahrbuch k. k. Geol. Reichsanstalt,* **19,** 428, 32 (1869).

Hauer, K. R. von and Conrad, J.—Arbeiten in dem Chemischen Laboratorium der k. k. Geol. Reichsanstalt. (Clay Analyses.) *Jahrbuch,* **25,** 141–206 (1875).

Herold, H.—Über die Kaoline der Formation des Mittleren Buntsandsteins in Thüringen. *Inaug. Dissert.* (1875). (Abs. in *Jahrb. für Min.,* 1875, p. 876 and *Jour. Chem. Soc. London,* **1,** 530 (1876).)

Herrman, O.—Section Klaster St. Marienstern. (Kaolin near Lansitz.) *Erläuterungen zur geol. Specialkarte des Königreichs Sachsen,* No. 37 (1892).

Herrman, O.—Section Welka-Lippitsch. (Kaolin, Lausitz.) *Erläuterungen zur geol. Specialkarte des Königreichs Sachsen*, No. 23 and 28 (1893).

Herzberg, W.—Feuchtigkeitsgehalt des Kaolins. *Mitt. Tech. Versuchsanst.*, **20,** 336 (1902).

Höchst, J.—Das Vorkommen von plastischen Thon im Bergmeistereibezirk Diez. *Odernheimer, das Berg–und Hüttenwesen im Herzogthum Nassau*, Pt. 3, pp. 464–71.

Humperdink.—Über die Kaolinlager aus der Gegend von Halle. *Vertrag. Vers. deutsch. geol. Ges.* (1901). (Abs., *Zeits. f. prakt. Geol.*, p. 419 (1901).)

John, C. von.—Analysen aus dem Chemischen Laboratorium k. k. Geol. Reichsanstalt (Clay Analyses). *Jahrbuch k. k. geol. Reichsanstalt*, **42,** 172 (1892).

John, C. von and Foullan, H. B. von.—Arbeiten aus dem Chemischen Laboratorium der k. k. geol. Reichsanstalt (Analysen der Thone). *Jahrbuch*, **31,** 508 (1881); **36,** 348, 349 (1886); **38,** 630 (1888).

Kaul, H.—Geologisch Chemische Studien über die Thone und Lehmvorkommen um Nürnberg. *Inaug.-Diss. Erlangen*, 1900.

Kilroe, J. R.—On the Occurrence and Origin of Laterite and Bauxite in the Vogelsberg. *Geol. Mag.*, **5,** 534–42 (1908).

Kossmann.—Feuerbeständige plastische Thone aus Ober-und Niederschlesien. *Dingler's Polytech. Jour.*, **256,** 276 (1885).

Kossmann.—Kaolin in the Coal Measures of Germany. *Zeits. deutsch. geol. Gesell.*, **45,** 173–5 (1893).

Kraatz, K. von.—Die Ziegelthone von Braunschweig. *Zeits. f. prakt. Geol.*, pp. 409–11 (1897).

Kühn, O. B.—Analyse des Kaolins von Aue bei Schneeberg. *Schweiger's Jahrb. d. Chemie*, Pt. 9, p. 34 (1829).

Lang, J.—Über Bauxit von Langsdorf. *Bericht der Deutschen Chemischen Gesell.*, **17,** 2892–4 (1884). (Abs., *Neues Jahrb. f. Min.*, **11,** 342 (1886) and *Jour. Iron and Steel Inst.*, **1,** 293 (1886).)

Lang, J.—Über Kaolinit in Sandsteinen des Schwäbischen Mittleren Keupers. *Zentralbl. f. Min. usu.*, p. 596 (1909).

Lang, R.—Entstehung von Braunkohle und Kaolin im Tertiar Mitteldeutschlands (1921).

Lapparent, A. de.—Revue de géologie. (Kaolin in Thuringia.) *Annal. de Min.*, **18** [7], 364 (1877).

Lasaulx, A. v.—Pholerit und feuerfeste Thone von Neurode. *Sitzungsber. Niederrhein. Ges. Natur-u. Heilk.*, **43,** 10 (1886).

Laspeyres, H.—Blatt Petersberg (Kaolin). *Erläuterungen zur Geologischen Karte von Preussen*, 1874, No. 263.

Liebrich, A. v.—Bauxit. *Bericht der Oberhess. Gesellschaft für Natur. und Heilkunde*, **28,** 57–98.

Liebrich, A. v.—Beitrag zur Kenntnis des Bauxits von Vogelsberge. *Inaug. Dissert.* (1891).

Lincke, R.—Der Buntsandstein am Ostrande des Thüringer Beckens. (Kaolin, Thüringia.) *Neues Jahrb.*, 1871, p. 23.

Loretz, H.—Blatt Steinheid. (Kaolin Thuringia.) *Erläuterungen zur geologischen Specialkarte von Preussen und den Thüringischen Staaten.* Gradabteilung, **70,** No. 35 (1885).

Ludwig, R.—Bildung von Lehm, Thon aus Zersetztem Dolerit und Basalt. *Jahresber. Chemie*, p. 831 (1851).

Mathias, W.—The Clay and Loam Deposit at Hettenleidelsheim, in the Palatinate. *Zeits. f. prakt. Geol.*, pp. 133–44 (1920). (Abs. in *Jour. Iron and Steel Inst.*, **103,** 377 (1921).) (Abs., *Geol. Centralbl.*, **25,** 488 (1920–21).)

von **zur Muhlen, L.**—Kaolin and Kaolinized Granite in the District between Strobel and Saarau, Silesia and Their Formation. *Zeit. f. prakt. Geol.*, pp. 56–61 (1921).

Müller, L.—Das Kaolin und seine deck-

enförmigen Lagerstätten in Mittel-Deutschlands. *Der Steinbruch.*, pp. 79–80 (1910). (Abs., *Geol. Runds.*, p. 180 (1911).)

Pagels.—Feuerfester Thon bei Polnisch-neudorf. *Wochenschrift des Schlesischen Vereins für Berg-und Hüttenwesen.*, No. 4 (1861). (Abs. in *Dingler's Polytech. Jour.*, **159,** 238 (1861).)

Pollak, O.—Porzellanerde von Brenditz nächst Znaim. *Jahrbuch k. k. Reichsanstalt*, **3,** 162 (1852).

Prziwoznik, E.—Analyses of Bauxite. Berg.-u. Hüttenmännisches. *Jahrbuch der k. k. Bergakademien*, **15,** 564 (1865); **38,** 415, 416 (1888).

Randhahn, K.—Contribution to the Knowledge of Bunzlau Clay. Dissertation, 1907.

Rasel.—Die Oberpfälzer Kaolinindustrie. *Diss. Erlangen*, 1909.

Reinhold, T.—Eigenschappen en Samenstellung van einige Limburgsche Kleisoorten, Benevens de Bepaling van het Smeltpunt. *Polytechnisch Weekblad.*, **12** [47, 22], 523–26 (1918). (Abs., *Geol. Centralb.*, **24,** 172 (1919–20).)

Rieke, R.—Kaolin. *Sprechsaal*, **40,** 33 (1907).

Rieke, R.—The Replacement of English Kaolin (China Clay) by Domestic Materials. *Sprechsaal*, **48,** 183–5, 191–3, 199–201 (1915).

Ries, H.—Kaolins and Fire Clays of Europe. U. S. Geol. Surv., *Ann. Rept., Pt. VI (cont.)*, **19,** 411–35 (1897–98).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *Ann. Rept., Pt. VI (cont.)*, **21,** 382–4 (1901).

Rohland, P.—German and English Kaolins. *Papier Zeit.*, **39,** 2658 (1914).

Rösler, H.—Beitrag zur Kenntnis einiger Kaolinlagerstätten. *Neues. Jahrb. f. Min., Beil. Bd.*, **15,** 231–393 (1902). (Abs., *Geol. Centralb.*, **7,** 329 (1905–06).)

Sachs.—Bodenschätze Schlesiens (1906).

Sauer.—*Erläuterungen zur Geol. Specialkarte, Section Liebertwolkurtz. Rotha*, p. 45 (1905).

Schafhäutl.—Kaolin in Passau. *Corr.-Blatt. zoöl.-min. Ver.*, **2,** 118.

Schmid, E. E.—Die Kaoline des Thüringischen Buntsandsteins. *Zeits. deutsch. Geol. Gesell.*, **28,** 87–110 (1876). (Abs., *Jahrb. für Min.*, pp. 669–79 (1876); *Jour. Chem. Soc. London*, **2,** 119–20 (1877); *Ann. des Mines*, Ser. 7, **13,** 365–6 (1878).)

Schmitz, Ch.—Kaolin near Passau. *K.- und Gew.-Blatt*, p. 242 (1883).

Seemann.—Über die Ton-und Kaolingrubenindustrie westlich und südwestlich von Meissen. *Jahrb. f. d. Berg.-u. Hüttenwesen im Kgr. Sachsen*, pp. 3–24 (1902). (Abs., *Geol. Centralb.*, **4,** 686 (1904).)

Seger, H.—Über die Beziehungen zwischen der Zusammensetzung der Sennewitzer Kaoline und deren Verhalten im Feuer. *Ges. Schriften*, p. 527.

Seger, H.—Analyses of Clays from Breitscheid, Germany. *Stahl und Eisen*, **20,** 500.

Seger, H.—Untersuchung des Thones von Löthain. *Dingler's Polytech. Jour.*, **248,** 185 (1883). (Abs., *Jour. Chem. Soc.*, **44,** 627 (1883).)

Seger, H.—Analysirte Meissener Kaoline. *Dingler's Polytech. Jour.*, **256,** 277 (1885).

Seger, H.—Gesammelte Schriften, 908 pp. (1896).

Selle.—Über Verwitterung und Kaolinbildung Hallescher Quarzporphyre. *Zeits. f. Naturw.*, **79,** Pt. 5 and 6 (1907).

Sillem.—Über Pseudomorphosen. (Kaolin near Passau.) *Neues Jahrb.*, p. 389 (1851); p. 535 (1852).

Stahl, A.—Die Verbreitung der Kaolinlagerstatten in Deutschland. *Archiv. für Lagerstätten K. Preussischen Geol. Landesanstalt*, **12** (1912).

Stahl, A.—The Distribution of Kaolin Deposits in Germany. *Tonind. Zeit.*, **37,** 663–5.

Stahl, A.—Die Verbeitung der Kaolin-

lagerstätten in Deutschland. Diss., Berlin (1911). (Abs., *Geol. Centralb.*, **17**, 587 (1911–12).)

Steinberg, C.—Chemische Untersuchung Mehrerer Sorten Porcellanerde aus der Nähe von Halle a. S. *Jour. prakt. Chemie.*, **16**, 51 (1839).

Stremme, H.—Über die Beziehungen einiger Kaolinlager zur Braunkohle. *Neues Jahrbuch für Mineralogie, Geologie und Paläontologie*, **2**, 91–121 (1909).

Stremme.—Über Kaolinbildung im allgemeinen und die Entstehung der Lausitzer Kaolinlagerstätte im besonderen. *Sprechsaal* (1909).

Stutzer, O.—Die Weiss Erden-zeche St. Andreas bei Aue. *Zeits. f. prakt. Geol.*, **13** [9], 333–7 (1905). (Abs., *Geol. Centralb.*, **7**, 635 (1905–06).)

Tannhaüser, F.—Zur Entstehung der Neuroder feuerfesten Schiefertone in der Grafschaft Glatz. *Zeits. f. prakt. Geol.*, **17**, 522–4 (1909).

Tietze, E.—On Fire Clays. *Jahrb. k. k. Reichsanstalt*, **2**, 317–30.

Tietze, O.—Das Steinkohlengebirge von Ibbenbüren. *Jahrb. K.-preuss. geol. Landesanstalt*, **29**, 349 (1912).

Vasel, A.—The Quantity and Composition of Colloid Clay in Kaolin from Meissen, *Kolloid-Zeit.*, **33**, 178–80 (1923).

Vohl, H.—Analyse einer Thonsorte von Klingenberg. *Dingler's Polytech. Jour.*, **199**, 496 (1871).

Voigt, J. C. W.—Kleine Mineralogische Schriften. (Kaolin, Thüringia.) Weimar, **2**, 130 (1800).

Waltl.—Porcellanerde bei Passau. *Schluprogramm* (1853) and (1862); and *Corr.-Blatt. zoöl.-min. Ver., Regensburg*, **2**, 78.

Watts, A. S.—Clay and Kaolin Mining in Europe. *Trans. Amer. Ceram. Soc.*, **13**, 228 (1911).

Weinschenk, E.—Beiträge zur Mineralogie Bayerns. (Kaolin near Passau.) *Zeit f. Krystallogr.*, **28**, 152 (1897).

Weinschenk, E.—Die Graphitlagerstätten des bayerischböhmischen Grenzgebirges. (Kaolin Passau.) *Abhandl. k. bayer. Akad. Wiss.*, **2** [19], 16 (1897).

Weiss, F.—Vorkommen und Entstehung der Kaolinerden des ostthüringischen Buntsandsteinbeckens. *Zeit. f. prakt. Geol.*, **18**, 353–67 (1910). (Abs., *Geol. Centralb.*, **16**, 1087 (1911).)

Weisz, F.—Review of Paper on Kaolins of East Thuringia. *Keram. Runds.*, **19**, 19 (1911).

Wineberger.—Versuch einer geognostischen. Schilderung des bayerischen Waldgebirges (Kaolin Passau.) p. 73 (1851).

Winkler, M.—Beitrag zur Geschichte der Kaolingruben der Königl. Porzellan-Manufaktur zu Meissen. *Jahrb. f. d. Berg.-u. Hüttenwesen im Kgr. Saschsen*, 129–34 (1902). (Abs., *Geol. Centralb.*, **4**, 686 (1904).)

Wirst, E.—Die Enstehung der Kaolinerden der Gegend von Halle a. S. *Zeits. f. prakt. Geol.*, **15**, 19–23 (1907).

Great Britain

Anon.—Bath Brick. *Chamb. Jour.*, **73**, 21–3 (1896).

Anon.—Kaolin Deposits of Cornwall. *Bull. Imp. Inst.*, **18**, 283–8 (1920). Notes based on articles by H. F. Collins in the *Mining Mag.* and on the Hensbarrow Granite District by J. H. Collins and on A Handbook to the Collections of Kaolin, China Clay and China Stone in the Museum of Practical Geology, Jermyn St., London, by J. Allen Howe.

Anon.—Brick Earths of Great Britain. *British Clayworker*, **9** (1900–01). (Abs., *Geol. Centralb.*, **1**, 741 (1901).)

Anon.—Some Yorkshire Claypits. *Quarry*, **5**, 515–24. (Abs. *Geol. Centralb.*, **1**, 294 (1901).)

Anon.—Pottery Clay in Tyrone. *British Clayworker*, **11**, 164 (1902–03).

Anon.—China Clay from Antrim. *British Clayworker*, **14**, 22 (1905–06).

Anon.—China Clay in Antrim. *British Clayworker*, **16**, 107 (1907–08).

Anon.—Coal and Fire Clay at Ballycastle. *British Clayworker*, **16**, 91 (1907–08).

Anon.—Irish Clays. *The British Clayworker*, **28**, 22 (1919–20).

Anon.—Brick Earths of Great Britain. *British Clayworker*, **10** (1901–02). (Abs., *Geol. Centralb.*, **3**, 207 (1903).)

Anon.—Reported Discovery of China-Clay near Wrexham. *British Clayworker*, **13**, 247 (1905).

Anon.—China Clay and China Stone of St. Austell. *The British Clayworker*, **18**, 311 (1909–10).

Anon.—South Devon Clays. *The British Clayworker*, **18**, 146 (1909–10).

Anon.—Cornwall and Devon Clays. *British Clayworker*, **19**, 128 (1910–11).

Anon.—Summary Rept. of Progress of the Geol. Surv. of Gr. Brit. for 1916. Abs. in *Jour. Iron and Steel Inst.*, **97** [1], 475 (1918).

Anon.—English China Clay for Hard Porcelains. *Pottery Gaz.*, **45**, 513 (1920).

Anon.—China Clay (Cornwall, Eng.). *Chem. Age*, **8**, 15 (1923).

Atkinson, J. B. and Stobbs, J. T.—The Geology of the Refractory Materials of the North of England. *Trans. Eng. Ceram. Soc.*, **18**, 435 (1919).

Ball, L. C.—China Clay as Worked in Cornwall. Queensland, *Govt. Mining Jour.*, p. 219 (1909).

Barrett, C. R. B.—Somersetshire: Highways, Byways and Waterways (1894).

Barrow, G.—The Geology of the Country around Padstow and Camelford. *Mem. Geol. Surv.* (1910).

Blackwell, G. G.—Bauxite. *Trans. Manchester Geol. Soc.*, **22**, 525–7 (1894).

Boase, H. S.—Contributions towards a Knowledge of the Geology of Cornwall. *Trans. Royal Geol. Soc.*, **4**, 235 (1832).

Bodin, V.—China Clay. *Science et Industrie*, **7** [108], 134–6 (1923).

Boulton, W. S.—Fire Clays of South Staffordshire. *Trans. of Eng. Ceram. Soc.*, **16**, 237–58 (1916–17). (Abs. in *Jour. Iron and Steel Inst.*, **98** [2], 438 (1918).)

Bulman, G. W.—Underclays: A Preliminary Study. (The Clays Underlying Coals.) *Geol. Mag.*, **9**, 351–61 (1892).

Burton, R. C.—Formation of Kaolinite in Some Coal-measure Shales of Northumberland. *Proc. Univ. Durham Phil. Soc.*, **4**, 24–9 (1911).

Butler, F. H.—Über Kaolin (Deals with Origin of Kaolinite in the Coal Measures of Glamorganshire, England). *Centralblatt für Mineralogie, Geologie und Paläontologie*, p. 426 (1911).

Cameron, A. C. G.—On the Continuity of the Kellaways Beds over Extended Areas near Bedford, and on the Extension of the Fullers' Earth Works at Woburn. *Rept. Brit. Assoc. Adv. Sci., 1891*, p. 636 (1892).

Cameron, A. C. G.—The Fullers' Earth Mining Company at Woburn Sands. *Geol. Mag.*, **9**, 469 (1892).

Church, A. H.—Red Chalk and Red Clay. *Chem. News*, **31**, 199 (1875). (Abs., *Jour. Chem. Soc.*, **13**, 872 (1875).)

Cock, D.—A Treatise on China Clay (1880).

Cock, D.—A Treatise, Technical and Practical on the Nature, Production and Uses of China Clay, with Several Useful Tables and Statistics Bearing on the Subject, 151 pp. (1880).

Cole, G. A. J.—The Rhyolites of the County of Anthrim [Ireland], with a Note on Bauxite. *Sci. Trans. Roy. Dublin Soc.*, Ser. II, **6**, 105–9 (1896).

Collins, H. F.—The China Clay Industry of the West of England. *Mining Mag.*, **21**, 269–75, 329–37 (1919) and **22**, 25–32, 94–7 (1920). (Abs. in *Bull. Imp. Inst.*, **18**, 283–8 (1920).)

Collins, H. F.—China Clay, Its Composition, Preparation and Uses. *Chemistry and Industry*, **42**, 88–91, 114–7 (1923).

Collins, J. H.—On China Clay and China Stone of Devon and Cornwall. *Jour. Soc. Arts*, **24**, 565–72 (1876).

Collins, J. H.—The Hensbarrow Granite District (1878).

Collins, J. H.—The China Clay Industry of Cornwall and Devon. *Popular Science Review, Littell's Living Age,* 434–8 (1878).

Collins, J. H.—Notes on China Clay and its Uses. *English Mechanic and World of Science,* **43,** 385 (1886).

Collins, J. H.—On the Nature and Origin of Clays. The Composition of Kaolinite. *Mineral. Mag.,* **7,** 205–14.

Collins, J. H.—Kaolin, or China Clay. *Eng. and Min. Jour.,* **79,** 1079–80 (1905).

Collins, J. H.—The China Clay Industry of Cornwall. *The Mining Magazine,* **4,** 449 (1911).

Collins, J. H.—Notes on Some Geological Features at the Carpalla China Clay Pit in the Parish of St. Stephen's, Cornwall. *Quart. Jour. Geol. Soc.,* **65,** 155 (1909).

Coon, J. M.—China Clay. *Trans. Eng. Ceram. Soc.,* **10,** 82 (1911).

Coon, J. M.—The Bloomdale China Stone and Clay Coy. *Trans. Eng. Ceram. Soc.,* **11,** 13 (1912).

Coon, J. M.—On China Stone, Cornish Stone or Petunzyte. *Trans. Royal Geol. Soc., Cornwall,* **8** [9], 561 (1913).

Cox, A. H.—Notes on Some South Staffordshire Fire Clays and Their Behavior on Ignition. *Geol. Mag.,* **6, 5** [644], 56–63 (1918). (Abs., *Geol. Centralb.,* **26,** 454 (1921).)

Davies, D. C.—The Fire Clays and Fire Clay Productions of North Wales. *British Architect,* Jan. 21 and Jan. 28 (1877).

Davies, D. C.—Earthy and Other Minerals and Mining, pp. 38–58 (1888).

Dewey, H.—The Refractory Materials of the London Basin. *Trans. Eng. Ceram. Soc.,* **22,** 38 (1923).

Dewey, H.—The Geology of the Bournemouth District. *Trans. Eng. Ceram. Soc.,* **22,** 293 (1923).

Ennos, F. R. and Scott, A.—Refractory Materials of Great Britain. Brit. Geol.-Surv. Special Rept., *Min. Res. Gr. Br.,* No. 28 (1924).

Etheride, R.—On the Occurrence of a Large Deposit of Terra Cotta Clay at Watcombe, Torquay. Abs. of paper before Brit. Assoc. at Exeter. *Ann. Scientific Discovery,* pp. 258–9 (1870).

Farie, J.—Notes on Pottery Clays: The Distribution, Properties, Uses and Analyses of Ball Clays and China Stone (1901).

Fearnsides, W. G.—Native Supplies of Refractory Materials Available in the Sheffield District. *Trans. Eng. Ceram. Soc.,* **18,** 280 (1918).

Firth, E. M., Hodkin, F. W. and Turner, W. E. S.—The Composition, Drying and Firing Shrinkage, Porosity and Sensity of British Fire Clays Suitable for Glass Furnace Refractory Material. *Jour. Soc. Glass Technology,* **4,** 162–204 (1920).

Fitton, W. H.—Porcelain Earths of Cornwall. *Ann. Phil.,* **3,** 180 (1814).

Flett, J. S.—The Geology of the Country around Bodmin and St. Austell. *Mem. Geol. Surv.,* p. 65 (1909).

Fryar, M.—Iron Ore and Fire Clay, Their Geological Formation and Methods of Working. *Lectures Delivered at Bristol Mining School, 1857,* pp. 290–300 (1859).

Garnett, C. S.—The "Toadstone Clays" of Derbyshire. *Mineralog. Mag.,* **20,** 151–7 (1923).

Gilligan, A.—The Lower Permian at Ashfield Brick and Tile Works, Conisborough. *Proc. York. Geol. Soc.,* **19,** 289–97 (1918).

Green, A. H.—Physical Geology. 3rd Ed, 1882. (8 Analyses of Typical Kaolin, p. 174. Clay of Organic Origin, p. 233.)

Gregory, J. W.—*Nature,* **80,** 148. (Abs. in *Jour. Iron and Steel Inst.,* **80** [2], 348 (1909).)

Gregory, J. W.—Glenboig Clay. *Proc. Royal Soc. of Edinburgh,* **30,** 348–60. (Abs. in *Jour. Iron and Steel Inst.,* **82** [2], 409 (1910).)

Gregory, J. W.—The Fire Clay of Glenboig, Lamarkshire. *Proc. Roy. Soc. Edin.*, **30,** 348–60 (1910).

Hambley and Spillers.—Analyses of Bricks, Clays and Porcelain Clays of Glasgow. *Chem. Gazette,* p. 100 (1856); *Chemisches Central-Blatt.*, p. 590 (1856).

Hinxman, L. W. and MacGregor, M.—The Distribution and Geological Position of the Valuable Fire Clays and Ganisters of the South of Scotland. *Trans. Eng. Ceram. Soc.*, **17,** 35 (1917–18).

Hinxman, L. W. and MacGregor, M.—Fire Clays and Ganisters of the South of Scotland. *Pottery Gaz.*, **42,** 1070 (1917).

Holland, P. and Dickson, E.—Remarks on the Formation of Clay. *Proc. Liverpool Geol. Soc.*, Pt. 1, **7,** 108–17 (1892).

Holland, T. H.—On the Constitution, Origin and Dehydration of Laterite. *Geol. Mag.*, **10,** 59–69 (1903).

Howe, J. A.—Notes on the Refractory Materials of South Wales. *Trans. Eng. Ceram. Soc.*, **18,** 27–42 (1919). (Abs. in *Jour. Iron and Steel Inst.*, **99** [1], 626 (1919).)

Hutchings, W. M.—Further Notes on Fire Clays etc. *Geol. Mag.*, p. 164, April, 1891.

Jackson, W. and Richardson, A. G.—The Clay Deposits of Cornwall and Devon. *Trans. Eng. Ceram. Soc.*, **3,** 44 (1905).

Jones, W. R. R.—Refractory Silica Materials of South Wales, with Special Reference to the Influence of Texture. *Trans. Eng. Ceram. Soc.*, **21,** 358–93 (1921–22).

Keeling, F. A.—Pike Bros. Dorset Clay Mines. *Trans. Eng. Ceram. Soc.*, **11,** 19 (1912).

Macadam, W.—Analyses of Samples of China Clay (Kaolinite), Cornwall. *Mineralogical Mag.*, **7,** 76 (1887).

MacAlister, D. A.—Summary of Progress for 1905. *Mem. Geol. Surv.*, p. 34 (1906).

Mac Alister, D. A., Usher, W. A. E., Barrow, G. and Flett, J. S.—The Geology of the Country around Bodmin and St. Austell. *Mem. Geol. Surv.* (1909).

Maw, G.—The Distribution beyond the Tertiary Districts of White Clays and Sands Subjacent to the Boulder-Clay Drifts. *Geol. Mag.*, **4,** 241–51, 299–307 (1867).

Maw, G.—Catalogue of Specimens Illustrating the Clays and Plastic Strata of Great Britain. *Appendix A to Catalogue of Specimens in the Museum of Practical Geol.*, pp. 213–52 (1871).

Maw, G.—The Source of the Materials Composing the White Clays of the Tertiaries. *Quart. Jour. Geol. Soc., London,* **23,** 387–94.

McDonald, D. P.—Glenboig Fire Clay. Paper read before Royal Soc. of Edinburgh. (Abs. in *The British Clayworker,* **19,** 14 (1910–11).)

Page, E. P. and Rees, W. J.—*Eng. Times,* **15,** 216 and 248–9. (Abs. in *Jour. Iron Steel Inst.*, **43** [1], 383 (1907).)

Quick, J.—Cornish China Clay. *Quart. Sci.*, **14,** 500–12 (1877); *Mining Journal, August,* p. 425 (1891).

Ries, H.—Kaolins and Fire Clays of Europe. U. S. Geol. Surv., *19th Ann. Rept., Pt. VI (cont.)*, pp. 402–10 (1897–98).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, **21,** 384–5 (1901).

Roberts, T.—The Upper Jurassic of Lincolnshire. *Quart. Jour. Geol. Soc.*, **45,** 543 (1889).

Sanford, P. G.—An Analysis of Fullers' Earth of Nutfield. *Geol. Mag.*, pp. 455–6 (October, 1889).

Sanford, P. G.—Analysis of Fullers' Earth of Urongoch, Near Bola, N. Wales. *Geol. Mag.*, April, p. 160 (1893).

Sargent, H. C.—On the Origin of Certain Clay-bands in the Limestone of the

Crich Inlier. *Geol. Mag.*, **9,** 406 (1912).

Scrivenor, J. B.—The Kaolin Veins. *Geol. Mag.*, **6, 5** [644], 79–82 (1918). (Abs., *Geol. Centralb.*, **26,** 395 (1921).)

Searles, A. B.—An Introduction to British Clays, Shales and Sands (1912).

Sortwell, H. H.—American and English Ball Clays. Bur. Standards, *Tech. Paper*, **17** [227], 153–82 (1923).

Sortwell, H. H.—The Properties of Some Ball Clays. *The Ceramist,* **2** [1], 5–15 (1922).

Stobbs, J. T.—Clays and Marls of North Staffordshire, *Pottery Gaz.*, **42,** 155 (1917); also *Trans. Eng. Ceram. Soc.*, **16,** 107 (1916–17).

Stoker, H. M.—China Stone and China Clays of Cornwall. *Jour. Soc. Arts*, **1,** 498–501 and 509–12 (1853). From the *Jour. Roy. Cornwall Polytechnic Soc.* (*20th Ann. Rept.*).

Taylor, H.—On the Chemical Constitution of the Rocks of the Coal Formation. (Analyses of Clays.) *Edinburgh Philos. Jour.*, **50,** 140 (1850–51). (Abs. in *Neues Jahrb. für Min.*, p. 329 (1852).)

Thomas, C. W.—The Composition of British Fire Clays. *The British Clay-worker,* **30,** 21 (1921–22).

Thompson, B.—Some Clay Beds by the Ouse. *Geol. Mag.*, **4,** 24 (1907).

Timmis, G. H.—Preparation and Properties of Fire Clay with Special Reference to the Stourbridge Pot Clay. *Trans. Eng. Ceram. Soc.* (*Refractory Mat. Sec.*), **16,** 197–204 (1916–17). *Iron and Coal Trades Rev.*, **94,** 635 (1917). (Abs. in *Jour. Iron and Steel Inst.*, **96** [11], 353 (1917).)

Trechmann, C. T.—A Deposit of Interglacial Loess, and Some Transported Preglacial Clays of the Durham Coast. *Quart. Jour. Geol. Soc.*, **75,** 173–203 (1920).

Wagstaffe, E. A.—*Jour. Soc. Chem. Ind.*, **25,** 101–3. (Abs. in *Jour. Iron and Steel Inst.*, **73** [1], 383 (1907).)

Watts, A. S.—Clay and Kaolin Mining in Europe. *Trans. Amer. Ceram. Soc.*, **13,** 238 (1911).

Wilson, G. V.—The Ayrshire Bauxitic Clay. *Memoirs Geol. Surv. Scotland,* 1922.

Wilson, W.—On the Fire Clay Manufacture of Scotland. *Van Nostrand's Mag.*, **9,** 353–60. *Proc. Edinburgh and Leith Eng. Soc. Iron World and Manufacturer* (1873).

Woodward, H. B.—Geology of England and Wales, p. 371. (Fullers' earth.)

Worth, R. H.—China Clay. The Geology of the Country around Ivybridge and Modbury. *Mem. Geol. Surv.*, p. 121 (1912).

Wright, W. B.—Age and Origin of the Lough Neogh Clays. *Quart. Jour. Geol. Soc.*, **80,** 486–8 (1924).

Greece

U. S. Consul at Athens. The Clay-Working Industries of Greece. *Jour. Soc. Arts,* **50,** 848–9 (1902). (Extract in *Sci. Am. Supp.*, **56** [1424], 22,823 (1903).)

Damour, A.—Note sur une hydrate d'Alumine Ferrugineuse Trouvée dans l'Île d'Égine, Grèce. *Bull. Soc. Géol. France,* **22,** 2nd Ser., 413–6 (1864–65).

McGinley.—Clay Working Industries of Greece. *U. S. Consular Reports,* **69,** 273–6 (1902).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI* (*cont.*), **6,** 385–6 (1901).

Hungary

Horváth, B.—Report from the Chemical Laboratory of the Royal Hungarian Geological Survey. *Magyar Kir. Foldtani Intezet Jelentese,* pp. 471–86 (1915); 511–30 (1916); (*Mineralog. Abstracts* **I,** 385).

Kalecsinszky, A.—A Magyar Korona Országainak Megvizsgált Agyagai. (Clays of Hungary.) *Publicationen der kgl. ungar. Geolog.*, Anst., 1–218 (1905). (Abs., *Geol. Centralb.*, **8**, 415 (1906); Abs., *Jour. Iron and Steel Inst.*, **73**, 383 (1907).)

Kalecsinszky, A. V.—Die Untersuchten Ton der Länder der Ungarischen Krone. *Kgl. Ungarische Geologische Anstalt*, 234 pp. (1906).

Lotti, B.—Ostungarische und Italienische Bauxite. *Zeit. f. prak. Geol.*, **16** [12], 501–4 (1908); (Abs., *Geol. Centralb.*, **13**, 455 (1909).)

Matyasovszky, J. v. and Petrik, L.—Detailkatalog der Thon,- Glas,- Cement,- und mineralfarbenindustrie dienenden Rohmaterialien Ungarns. *Kgl. ungar. Landesanst.* (1895).

Matyasovszky, J. v.—Hungarian Fire-Clay. *Trans. North of Eng. Inst. of Min. Engs.*, **34**, 23 (1884–85).

Petrik, L.—Hungarian Rhyolite Kaolins. *Sprech.*, **43**, 245 (1910).

Rozlozsnik, P.—Preliminary Report on the Bauxite Occurrences of Northern Bihar (Királyerdö). *Magyar Kir. Földtani Intézet Jelentèse* (Budapest), pp. 450–4 (1916); *Mineralog. Abs.*, **1**, 385.

Tökes, L.—Délmagyarország Agyagtelepei (Clays of Southern Hungary). *Természettudományi Füzetek*, **29**, 68–72 (1905). (Abs., *Geol. Centralb.*, **8**, 417 (1906).)

Ws.—Ungarische Kaoline und Kaolinartige Thone. *Sprechsaal*, **34** [35], 1217 (1901).

Iceland

Seger, H.—Zusammensetzung von Bauxit aus Iceland. *Dingler's Polytech. Jour.*, **224**, 334 (1880).

Italy

Aichino, G.—Le Bauxite. 84 pp. (1902?). (Reprinted from *Rassegna Mineraria*, **15**, 225–7, 243–4, 259–65, 276–8 (1901).)

Aichino, G.—Bauxite in Italy. *Eng. and Min. Jour.*, **74**, 41 (1902).

Anon.—Bauxite and Alumina in Italy. *Eng. and Min. Jour.*, **76**, 810 (1903).

Anon.—Kaolin. Rivista del Servizio Minerano (1912).

Barelli, V.—Cenni di Statistica Mineralogica degli Stati di, S. M. il Re di Sardegna, 278 (1835).

Bombici, L.—Kaolin in Province of Bologna. Descrizione della Mineralogia Generale della Provincia di Bologna. Part II.

Brongniart, A.—Traité des Arts Céramique, p. 49–50.

D'Achiardi, G.—Kaolin at Jano near Volterra. Sopra Alcuni Minerali dell' Elba.

De Marchi, L.—Un Giacimento di Caolino nell' Agordino. *Estr. d. Atti e Mem. d. R. Acc. di Sc.*, **23** [4], 1–6 (1907). (Abs., *Geol. Centralb.*, **13**, 9 (1909–10).)

Ferro, A. A.—L'origine delle terre Gialle Veronesi. *Atti. Soc. ligustica di Sc. Nat. e Geogr.*, **16** [3], 179–97 (1905). (Abs., *Geol. Centralb.*, **7**, 515 (1905–06).)

Formenti, C.—Analysen von Vermeutlichen Italienischen Bauxiten. (Extr. from *Gazz. Chim. Ital.*, **31**, 455 (1901).) Groth's *Zeits. f. Krystallog. u. Min.*, **37**, 406 (1903).

Formenti, C.—Analysen von Italienischen Bauxiten. (Extr. from *Gazz. Chim. Ital.*, **32**, 453 (1902).) Groth's *Zeits. f. Krystallog. u. Min.*, **40**, 109–10 (1905).

Formenti, C.—Analisi di Supposte Bauxite Italiana. *Gazz. Chim. Ital.*, **31**, 452–5 (1901).

Girasoli, D.—Sull' Argilla Gialla di Ruvo (Bari). *Atti. R. Ist. d'Incoraggia-*

mento, **60** [6], 15–7 (1909). (Abs., *Geol. Centralb.*, **14**, 371 (1910).)

Guili.—Kaolin at Querceto and Ajola. Statistica Mineralogicci della Toscana.

Lotti, B.—Ostungarische und Italienische Bauxite. *Zeit. f. prak. Geol.*, **16** [12], 501–4 (1908). (Abs., *Geol. Centralb.*, **13**, 455 (1909).)

Martelli, G.—I Giacimenti Bauxitici di Civita d'Antino e Balsorano (Abruzzo). *Rass. Min.*, **29** [4, 5], 49–52, 68–9 (1908). (Abs., *Geol. Centralb.*, **13**, 9 (1909–10).)

Matteucci, R. V.—Kaolin at Torniella. *Boll. dello Soc. Geol. Italiana*, **10**, 664 (1891).

Novarese, V.—Der Bauxit in Italien. *Zeit. f. prakt. Geol.*, pp. 200–301 (1903).

Panichi.—Kaolin in Province of Grosseto. *Rend. R. Accad. Lincei*, **19**, 656 (1910).

Parlati, L.—Studio Analitico di Alcune Materie Prime Ceramiche. *Atti R. Ist. Incoragg.*, **61** [6], 463–77 (1910). (Abs., *Geol. Centralb.*, **16**, 84 (1911).)

Parlati, L.—Sulla Possibile Applicazione Industriale di Alcune Argille de Montescaglioso (Potenza). *Atti R. Istit. di Incoraggiamento*, **62**, 289–96 (1911). (Abs., *Geol. Centralb.*, **16**, 554 (1911).)

Parlati, L.—Studio Analitico di Alcune Argille di Caltanisetta. *Atti R. Ist. di Incoraggiamento*, **63** [6], 159–69 (1912). (Abs., *Geol. Centralb.*, **18**, 250 (1912–13).)

Parlati, L.—Sulla Possibile Applicazione Industriale di Alcune Argille di Montescaglioso (Potenza). *Atti R. Istit. di Incoraggiamento*, **62**, 289–96 (1911). (Abs., *Geol. Centralb.*, **20**, 648 (1913–14).)

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, pp. 386–8 (1901).

Ristori, G.—Le Terre Refrattarie e da Ceramica fra Altopascio e Monte Carlo (prov. di Lucca). *Giornale di Geol. pratica*, **2** [1–2], 43–9 (1904). (Abs., *Geol. Centralb.*, **8**, 332 (1906).)

Salle, E.—Il Caolino dei Dintorni della Spezia. *Pr. verb. Soc. tosc.*, **12**, 103–6 (1900). (Abs., *Geol. Centralb.*, **2**, 233 (1902).)

Tacconi, E.—Sul Deposito Argilloso di Tartavalle in Valsassina. *Rend. R. Inst. Lombardo di Sc. e Lett.*, **45** [2], 4 (1912). (Abs., *Geol. Centralb.*, **19**, 197 (1913).)

Ugolini, R.—La terra Refrattaria di Lugnano in Provincia di Pisa. *Proc. Verb. Soc. Tosc. Sc. Nat.*, **21**, 5–15 (1912). (Abs., *Geol. Centralb.*, **18**, 249 (1912–13).)

Zezi, P.—I Caolini e le Argille Refrattarie in Italia. *Boll. Com. Geol. d'Italia*, **6**, 299 (1875).

Luxemburg

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 388 (1901).

Monaco

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 389 (1901).

Norway

Dietrichson, B.—Undersökelser over Norske Lerer (Investigations of Norwegian Clays). Part II. Norges Geologiske Undersökelse, *Bull.* **116** (1923).

Dietrichson, B.—Investigations of Nor-

wegian Clays. Norges Geologiske Undersökelse, *Bull.* **120,** 1–52 (1924).

v. **Krogh, J.**—Undersökelser over Norske Lerer (Investigations of Norwegian Clays). Pt. III. Norges Geologiske Undersökelse, *Bull.* **119** (1923). Pt. I. *Ibid.,* **115** (1923).

Reusch, H.—En Forekomst af Kaolin og Ildfast ler ved Dydland naer Flekkefjord. *Norges Geol. Undersög.,* **32,** Aarbog for 1900, 99–103, Engl. Resumé, p. 235. (Abs., *Geol. Centralb.,* II, p. 517 (1902).)

Ries, H.—Kaolins and Fire Clays of Europe. U. S. Geol. Surv., *19th Ann. Rept., Pt. VI (cont.),* pp. 450–1 (1897–98).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.),* p. 389 (1901).

Vogt, J. H. L.—Problems in the Geology of Ore Deposits. (Kaolin, Ekkersund-Soggendal.)

Poland

Miernik, W.—Glinki z. niektórych Miejscowošči gub. Radomskiej. *Chemik Polski.* (Der Polnische Chemiker, red. v. Br. Miklaszewski), **9,** 268–72 (1909), (Abs., *Geol. Centralb.,* **14,** 126 (1910).)

Rutkowski, J.—Gliny i Wapienie Potudniowej Cze̋šči Powiatu Czestochowskiego. *Chemik Polski.* (Der Polnische Chemiker, red. v. Br. Miklaszewski), **9,** 148–51 (1909). (Abs., *Geol. Centralb.,* **14,** 129 (1910).)

Portugal

Brongniart, A. and Malaguti.—Über den Ursprung und die Zusammensetzung der Kaoline oder Porcellanthone, 1841; *Pogg. Annal,* **60,** 89 (1843); *Jour. prakt. Chemie,* **31,** 129 (1844).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.),* p. 389 (1901).

Roumania

Anon.—Kaolin Deposits in the Dobrudja. *Jour. Soc. Chem. Ind.,* **41,** 571R (1922)

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.),* p. 389 (1901).

Savul, M.—Kaolin of Sarisor, Falticeni District, Suceava, Roumania. *Bull. soc. Sci. Acad. Roumaine,* **8,** 197 (1923).

Russia

Anon.—Discovery of Kaolin, etc., in Russia. *Pottery Gaz.,* **47,** 1703 (1922).

Aljexjejeff, W.—Über den Thon von Kossoi Brod an der Tschussowaja. (Extr. from *Verh. d. k. russ. min. ges.,* **35** [2], 63 (1897); Groth's *Zeit. f. Krystallog. und Min.,* **31,** 509 (1899).

Bogndanoff, S.—Analyse des Argiles de Kiew. *Bull. Soc. Chimique,* **2,** pp. 40, 72.

Brongniart, A.—Über Porcellanerde, etc. *Bull. Soc. Géol. France,* **10,** 56 (1839); *Compt. rend.,* **7,** 1085; *Jour. prakt. chemie,* **17,** 118 (1839).

Brongniart, A. and Malaguti.—Über den Ursprung und die Zusammensetzung der Kaoline oder Porcellanthone. (2nd Ed., 1841); *Pogg. Annal.,* **60,** 89 (1843); *Jour. prakt. chemie,* **31,** 129 (1844).

Chirvinskii, P. N.—Microscopic and Chemical Investigation of Several Sedimentary Rocks of the Cretaceous and Tertiary Formations near Wolsk, Govt. Saratow. *Bull. Inst. Poly-*

techn., **4** [2], 122–40 (1915); *Mineralog. Abstr.*, **2**, 73–4.

Fersman, A. E.—Russian Deposits of Fullers' Earth and Allied Substances. *Reports on Natural Productive Forces of Russia,* **1** (1916).

Glinka, K.—Über die Mineralogische Zusammensetzung der Pskower Glacialen Thone und über die Verwitterungstypen. *Verhandl. St. Petersb. kais. min. Ges.*, **2** [37], 333. (Abs., *Geol. Centralbl.*, p. 98 (1901).)

Lawroff, A.—Die Fahrt nach Kissatib, Kreis Achalzich. Mess. d. l'Art. minièr, et d. l'Irrigation au Caucase, No. **21** (1902). (Abs., *Geol. Centralb.*, **4,** 204 (1904).)

Licharew, B.—Die Feuerfesten Tone der Region Tschassowo-Jarsk, Gouv. Jekaterinoslav. *Russische Geologische Comité,* No. **31,** 25 pp. (1918). (Abs., *Geol. Centralb.*, **28,** 160 (1922–23).)

Meffert, B.—Die Tone der Wasserscheide Kama-Wiatka. *Russiche Geologische Comité,* 28 pp., No. **37** (1918). (Abs., *Geol. Centralb.*, **28,** 160 (1922–23).)

Prigarovskii, M. M.—Refractory Clays of Central Russia. Russ. Acad. Sci., *Matter on Natural Resources of Russia,* **35,** 1–59 (1922). (Abs., *Rev. Geol.*, **5,** 98–9.) (Abs., *Geol. Centralbl.*, **19,** 520 (1923).)

Ries, H.—Kaolins and Fire Clays of Europe. U. S. Geol. Surv., *19th Ann. Rept., Pt. VI (cont.)*, 451–5 (1897–98).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 390 (1901).

Samoilov, J. V.—Labrador und Kaolin aus Bezirk Elisavetgrad, Gov. Cherson. *Bull. Soc. Imp. Nat. Moscow.*, p. 520 (1903); New Series, **16,** 520 (1903).

Schindelmeiser, J.—Analyse einer Kaukasischen Erdart. *Ber. d. deutschen Pharmaz. Ges.*, **13** [7] (1903). (Abs., *Geol. Centralb.*, **4,** 437 (1904).)

Semjatschenski, P. A.—Die Absorptionseigenschaften der Russischen Tone. *Russ. Akademie der Wissenschaften, Kom. zur Erforschung der Bodenschätze Russlands,* No. **27,** Pts. 1 and 2, 1–67 (1921). (Abs., *Geol. Centralb.*, **19,** 520 (1923).)

Silberminz, W. A.—Die Tonlagerstätten im Kreis Wytegra, Gouv. Olonezk. *Russische Geologishe Comité,* No. **55,** pp. 1–66 (1921). (Abs., *Geol. Centralb.*, **28,** 160 (1922–23).)

Sjögren, H.—Preliminära meddelanden från de Kaukasiska Naftafälten. *Geol. fören Förhandl.*, **13,** 89.

Stopnevich, A. D., Iskul, V. I. and Ovsianikov, B. P.—The Bauxite of Tikhvin from the Geological Chemico-Mineralogical and Technical Points of View. Accad. Sci. Russia, *Matter on the Natural Resources of Russia,* **31,** 1–74 (1919). (Abs., *Rev. Geol.*, **5,** 82–3.)

Walter, H.—Das Kaolinvorkommen von Palanka Gouvernement Podolien. *Zeits. f. prakt. Geol.*, 392–3 (1898).

Warsonofiewa, W. und E. Soschkina.—*Bericht über Untersuchungen der feuerfesten Tone des Gouv. Perm. Erzbote,* **2** [2], 72–81 (1917), [3], 131–46. (Abs., *Geol. Centralb.*, **28,** 232 (1922–23).)

Zemjatschensky, C.—Kaolin and Clays from Kiew, Russia. *Bericht und Forschungen zur Keramischen Industrie in Russland,* **6,** 308–28.

Zemjatschenski, P.—Kaolin in Ekaterinoslav Province. *Trav. d. l. Soc. d. Natural,* p. 1 (1896).

Sardinia

Repossi, E.—The Kaolin Deposit of Furtei in Sardinia. *Rass. min. met. chim.*, **61,** 1 (1924). (Abs., *Chem. Age,* **11,** 15 (1924).)

Servia

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Serv., *21st Ann. Rept., Pt. VI (cont.)*, p. 390 (1901).

Spain

Calderôn, D. S.—Los Minerales de España, **2,** 410 (1910).

Calderôn and Tenne.—Die Mineralfundstätten der Iberischen Halbinsel (1902).

Lindley, W.—Recent Visit to Some Spanish and Portuguese Potteries. *Trans Eng. Ceram. Soc.,* **20,** 72–82 (1921).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.),* p. 390 (1901).

Sweden

Anon.—Swedish Kaolin. *British Clayworker,* **12,** 6 (1903–04).

Anon.—Statens Järnvägars Geotekniska Kommission Slutbetänkande, 1922. (The Final Memorial of the Geotechnical Commission of the State Railroads.) *Geotekniska Neddelanden,* **2** (1922).

Atterberg, A.—Mekaniska Jordanalysen och Klassifikationen af de Svenska Mineraljordslagen. (The Mechanical Analyses of Earth and the Classification of the Swedish Mineral Strata.) *Kungl. Lantbruks.-Akademiens Handlingar och Tidskrift,* 1912.

Beckman, J. W.—Ceramics as a By-Product of Coal Mining in Sweden. *Chem. Met. Eng.,* **25,** 882.

De Geer, G.—Om Kaolin och Andra Vittrings-rester af Urberg Inom Kristianstadsområdets Kritsystem, *Geol. Fören. i Stockholm, Förhandl.,* **7,** Pt. 12 (1885).

Cronquist, A. W.—Kaolin von Hultabo in Schweden. *Geol. Fören. Stockholm,* **5,** 525 (1880).

Eichstädt, F.—Bidrag till Kännedomen om Kaolinlernorna i Skåne. *Geol. Fören. i. Stockholm, Förh.,* **10** [2], 82–112 (1888).

Grönwall, K. A.—Enny profil i Hörs Sandsten. *Geol. Fören. Stockh., Förh.* **20,** 325 (1898).

Holmström, L.—Anteckningar om Stenindustrien i Noraöstra delen af Skåne. *Geol. Fören. Stockh., Förh.,* **21,** 261 (1899).

Lilienberg, N.—Fire Clays and Fire Bricks in Sweden. (Analyses; Machines for Grinding Clays.) *Trans. Amer. Inst. Min. Eng.,* **13,** 320–30 (1884–85).

Lindström, A.—Om Förekomsten af Kaolin och Kol in blandad lera i Norra Skåne. Nit liner Kartenskizze. *Geol. Fören. i Stockholm, Förh.,* **6** [10], 416–25 (1883). (Abs., *Neues Jahrb. Min.,* **2,** 365 (1883).)

Lindström, A.—Om Förekomsten af Kaolin och Kol in blandad lera i Norra Skåne. *Geol. Fören. i Stockholm Förhandl.* **6** [10], 416 (1882–83). (Abs. Neues Jahrb. Min., **2,** 365, 366 (1883).)

Lindström, A.—Kaolin in Sweden. (Abs. in *Trans. North of England Inst. Min. Eng.,* **32,** 53 (1884).)

Lundgren, B.—Über Kaolin von Schonen. Malmöhus läns Hush. Sällskaps Handlingar (1868–69).

Moberg, J. C.—Om Kaolinfyndigheten å Ifö. *Geol. Fören. Stockh., Förh.,* **25,** 259–81 (1903).

Müller, A.—Mittheilungen aus der neueren Geologie Schwedens. *Jour. für prakt. Chemie,* **90,** 385–99. (Thon von Werunland, p. 394.)

Müller, A.—Analysen Schwedischer Thon-und Erdarten. *Jour. für prakt. Chemie,* **90,** 395–9. (Abs., *Neues Jahrbuch für Mineral.,* p. 478 (1864).)

Natharst, A. G.—Elaüterungen zur geologischen Karte Trolleholm. *Sveriges geol. Undersökn.,* Ser. Aa., No. 87, 8 (1885).

Odelstjerna.—Über den Kaolin von Ifö in Schweden. *Oesterr. Zeitschr, f. Berg.-u. Hüttenw.,* 492–4 (1902). (Abs., *Geol. Centralb.,* **3,** 575 (1903).)

Odén, S. and Reuterskiöld, A.—Zur Kenntnis des Ancylustons. *Bull. Geol. Inst. Univ. Upsala,* **16,** 10 (1919).

Ries, H.—Kaolins and Fire Clays of

Europe. U. S. Geol. Surv., *19th Ann. Rept., Pt. VI (cont.)*, **51,** 448–51 (1897–98).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, pp. 390–1 (1901).

Santesson, B.—Kaolinfyndigheten vid Hultebo i Skinnskattebergs Socken och Örebro län. *Geol. Fören. i Stockholm Förhandl.*, **6,** 325 (1882–83).

Santesson, B.—Kaolin in Sweden. (Abs., *Trans. North of Eng. Inst. Min. Eng.*, **32,** 53 (1884).)

Switzerland

Balmer, Ch.—Der Thon. *Verhandl. d. schweiz. naturf. Ges.*, **84.** *Jahresvers. zu Zofingen, 1901,* **4–6** [8], p. 305 (1902), Protokollnotiz (Jb. v. Basel-land). (Abs., *Geol. Centralb.*, **3,** 575 (1903).)

Goppelstroder, F.—Über feuerfesten Thon den Umgebung von Basel. *Jour. für prakt. Chemie,* **101,** 444 (1867).

Graeger.—Analyse einiger Thone von Lengenau im Solothurn (Schweiz). *Dingler's Polytech. Jour.*, **188,** 420–1 (1868).

Letsch, E., Zschokke, B. und Moser, R.—Die schweizerischen Tonlager. *Beitr. z. Geol. der Schweiz, geotechn.* Ser. 4, Part 4. (Abs., *Geol. Centralb.*, **10,** 394 (1907–08).)

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 391 (1901).

Schmidt, C. and Hinden, F.—Geological and Chemical Investigation of the Clay Deposits at Alsace and at Allschwyl near Basle. *Zeits. prak. Geol.*, **15,** 46–56 (1907). (Abs., *Geol. Centralb.*, **12,** 27 (1909).)

Zschokke, B.—Die Untersuchung der Tonlager des Schweizerischen Ziegler-vereins in der eidgenössischen. *Materialprüfungsanstalt am schweizerischen Polytechnikum.*, **8,** 44 (1902). (Abs., *Geol. Centralb.*, **4,** 74 (1904).)

Turkey

Ries, H.—Clayworking in Turkey. *The Clayworker,* **30,** 9 (1898).

ASIA

Ceylon

Grünling, F.—Über die Mineralvorkommen von Ceylon. *Zeits. f. Krystall.*, **33,** 229 (1900).

China

Anon.—Clays in Manchuria. *The British Clayworker,* **16,** 238 (1907–08).

Anon.—White Earth, Its Competition with China Clay. *British Clayworker,* **29,** 18–9 (1920).

Anon.—The Ceramic Industry in China. *The British Clayworker,* **31,** 232 (1922–23).

Anon.—Chinese Kaolin for American Potteries. *Far Eastern Rev.*, **18,** 511–4 (1922).

Clements, J. M.—Chinese Clays for Export. *Brick,* **61,** 562 (1922).

Clements, J. M.—Kaolin Available in China. *Commerce Reports,* No. **15,** 85 (1922).

Du Halde.—Description de l'empire de la Chine et de la Tartare Chinoise. La Haye, 1736, Tome 2: English translation by R. Brooks. *The General History of China,* **2,** 3rd ed., 308, London (1741). Kaolin.

Du Halde and Julien, S. A.—Kaolin near Ching-tê-Chên. Histoire et fabrication de la Porcelaine Chinoise (1856).

Ebelmen and Salvétat.—Analysis of Kaolin from China. *Annal. chim. phys.*, **31** [3], 257 (1852).

Kalmann, W.—Analysen von Chinesischen Porzellanerden und Glasurmassen. *Ding. Polytech. Jour.*, **220**, 445–6 (1876).

Pabst, W.—Untersuchung von Chinesischen und Japanischen zur Porzellanfabrikation verwendten Gesteinsvorkomminssen. *Zeits. Deutsch. Geol. Gesel.*, **32**, 223 (1880).

Richtofen, F. v.—On the Porcelain Rock of China. *Amer. Jour. Sci.*, 3rd Ser., **1**, 179–81 (1871).

Vogt, G.—De la Composition des Roches Employées dans la Fabrication de la Porcelaine en Chine. *Compt. rend.*, **110**, 43 (1890).

Whitfield, E.—Analyses of Two Porcelain Clays from China. U. S. Geol. Surv., *Bull.* **27**, 71–2 (1886).

India

Boudouard, O. and Lefranc, J.—Clays. III. Clays of Hamman-Meskoutine. *Bull. Soc. Chim.*, **33**, 581–7 (1923).

Conrad, R.—Clay Industry of Southern India. *Tonind. Zeit.*, Sept. 2, 1339 and Sept. 4, 1347 (1913).

Dunstan, W. R.—Report on Laterite from the Central Provinces of India. *Rec. Geol. Surv. Ind.*, **32**, 213–20 (1903–04).

Fermor, L. L.—Clay in India. *Geol. Surv. of India., Records,* **53**, 256 (1922).

Fox, C.—The Bauxite Resources of India. *Min. Mag.*, **26**, 82–96 (1922).

Granger, A. A. and Brémond, P.—Note on the So-called Kaolin of Djebel-Debar. *Trans. Eng. Ceram. Soc.*, **22**, 283 (1923).

Gyengar, P. S.—Notes on Some Kaolin and Clay Occurrences in the Koppa Taluk. *Records, Dept. Mines and Geology, Mysorse State,* **15**, 118 (1916).

Knight-Hallowes, K. A.—The China Clay of Karalgi, Khanapur, Belgaum District. *Rec. Geol. Surv. Ind.*, **55**, 260–7(1923).

Lang, R.—Geological-Mineralogical Observations in India. II. Recent Brown Earth and Humus Formation. *Centr. Min. Geol.*, pp. 513–8, 545–51 (1914); *Ibid*, pp. 257–61.

Ras, B. B.—Notes on Prospecting for Kaolin in the Koppa Taluk. *Records, Dept. Mines and Geology, Mysore State,* **15**, 138 (1916).

Stuart, M.—China Clay and Fire Clay Deposits in the Rajmatah Hills. *Rec. Geol. Surv. India,* **38**, Pt. 2, 133–48 (1909).

Warth, H. and Warth, F. J.—The Composition of Indian Laterite. *Geol. Mag.*, **10**, 154 (1903).

Japan

Abbott, J. F.—Pottery Making in Japan. *Clayworker,* 596–7, 646 (1920).

Anon.—Fire Clay in the Vicinity of Taira, in the Prefecture of Tukushima. Imp. Geol. Surv. Japan. *Ind. Min. Surv. Rept.*, **3**, 47–82 (1921). (Abs., *Geol. Centralb.*, **28**, 457 (1922–23).)

Anon.—Refractory Materials Produced at the Kanakura Mine. *Jour. Jap. Cer. Assoc.*, **32**, 251 (1924).

Hojo, K.—Porcelain Clay at Shinobu-Yama in the Prefecture of Fukushima. Imp. Geol. Surv. Japan., *Ind. Min. Surv. Rept.*, **1** [1–11] (1921).

Hojo, K.—Porcelain Clay at Nakanokawa-Mura, Onuma-Gori. Imp. Geol. Surv., Japan, *Ind. Mineral. Surv. Rept.*, **1** [1–11], 81–9 (1921).

Hojo, K.—Porcelain Clay at Okinashima-Mura, Yama-gori, Prefecture Fukushima. Imp. Geol. Surv. Japan,

Ind. Mineral. Survey Rept., **1** [1–11], 91–102 (1921).

Hojo, K.—Porcelain Clay at Oki-Mura, Onuma-Gori. Imp. Geol. Surv., Japan, *Ind. Mineral Surv. Rept.*, **1** [1–11], 61–79 (1921).

Hojo, K.—Porcelain Clay at Naganuma, Iwase-Gori, Prefecture Fukushima. Imp. Geol. Surv., Japan, *Ind. Mineral Surv. Rept.*, **3**, 31–46 (1921).

Hojo, K.—Porcelain Clay at Hongo-Yama, Onuma-Gori, Prefecture Fukushima. Imp. Geol. Surv. Japan, *Ind. Mineral Surv. Rept.*, **1** [1–11], 37–60 (1921).

Hojo, K.—Fire Clay in the Vicinity of Taira, in the Prefecture of Fukushima. Imp. Geol. Survey of Japan, *Ind. Mineral Survey Rept.*, **3**, 47–82 (1921); *Japan J. Geol. Geog.*, **1**, 13A.

Hojo, K.—Clay, Quartzite, Pumiceous Sand and Fluorite in the Prefecture of Miye. Imp. Geol. Surv. Japan, *Ind. Mineral Surv. Rept.*, 10 (1922); *Japan T. Geol. Geog.*, **2**, 10A.

Hojo, K.—Clays of Mount Hongo in Fukushima Prefecture. *Jour. Japan. Ceram. Assoc.*, **355**, 98–105 (1922).

Ihara, K.—Clay at Nankwan in the Prefecture of Kumamoto. Imp. Geol. Surv. Japan, *Ind. Min. Surv. Rept.*, **7**, 41–9 (1922); *Japan J. Geol. Geog.*, **1**, 24–5A.

Ihara, K.—Clays and Steatite, Gotō Island, Nagasaki-Ken (Western Japan). Imp. Geol. Surv. of Jap., *Ind. Min. Surv. Rept.*, **4** (1921).

Ihara, K.—Porcelain Clay Deposits in Saga Prefecture. Imp. Geol. Surv. Japan, *Ind. Min. Surv. Rept.*, **5**, 1–48 (1921). (Abs., *Geol. Centralb.*, **19**, 390 (1923).)

Ihara, K.—Clays of Sagaken (Western Jap.). Imp. Geol. Survey of Jap., *Ind. Min. Surv. Rept.*, **5** (1921).

Ihara, K.—Ceramic Materials in the Saga Prefecture. *Jour. Jap. Ceram. Soc.*, **3**, 353 (1922).

Julien, S. A.—Mémoire sur les Principales Fabriques de Porcelaine au Japan. *Histoire et Fabrication de la Porcelaine Chinoise*, 275 (1856).

Kimura, R.—Clay and Quartz Sand of Soma and Futaba Counties, in the Prefecture of Fukushima. Imp. Geol. Surv. Japan, *Ind. Min. Surv. Rept.*, **9** (1922); *Japan Jour. Geol. Geog.*, **2**, 13–4A.

Koyama, K., Ishida, T., Nakamura, Y.—Roofing Tile Industry in Ishikawa Prefecture. *Jour. Jap. Ceram. Assoc.*, **369**, 243–54 (1923).

Kujono, N.—Distribution of the Industrial Minerals in Japan. Imp. Jap. Geol. Surv., *Ind. Min. Rept.*, **2** (1921).

Kujono, N.—Clay, Quartz Sand and Feldspar in the Environs of Seto, Aichi Prefecture. Imp. Geol. Surv. Japan, *Ind. Min. Surv. Rept.*, **11** (1922); *Japan Jour. Geol. Geog.*, **2**, 12–3A.

Kujono, N.—Porcelain Clay and Fire Clay in the Northern Part of Nishikamo County, Aichi Prefecture. Imp. Geol. Surv. Japan, *Ind. Min. Surv. Rept.*, **10** (1922); *Japan Jour. Geol. Geog.*, **2**, 9–10A.

Matsuno, K.—Clay at Imbé, Wake-Gori. Prefecture Okayama. Imp. Geol. Surv. Japan, *Ind. Min. Surv. Rept.*, **2**, 79–85 (1921).

Notomi, S.—Report on the Clay Used for Soma Wares. Jap. Geol. Survey, *Bull.* No. **67**.

Okazawa, T.—Studies on Clays. I. The Acid Reaction of Japanese Acid Clays. *Bull. Inst. Phys. Chem. Research* (Jap.), **2**, 189–221 (1923).

Pabst, W.—Untersuchung von Chinesischen und Japanischen zur Porzellanfabrikation verwendten Gesteinsvorkommnissen. *Zeits. Deutsch. Geol. Ges.*, **32**, 223 (1880).

Shigomune, R.—Comparative Examination of Japanese and Foreign Porcelain. Tokio Ind. Lab. Report, **17** [6], 59 (1922).

Soga, M.—Clays of the Chita Peninsula, Aichiken (Central Japan). Imp. Jap. Geol. Surv., *Ind. Min. Surv. Rept.*, **7** (1921).

Suzuki, T.—On Clay. *Jour. Jap. Cer. Assoc.*, **370,** 310–4 (1923).

Wurtz, H.—The Chemistry and Composition of the Porcelains and Porcelain Rocks of Japan. *U. S. Inter. Exhibition*, **3,** 604–37 (1880); also *Amer. Jour. Sci.*, **13** [35], 389–90 (1877).

Korea

Kitamura, Y.—Investigation of Gairome Clay found in Seikirei, Korea. *Jour. Chem. Ind. Tokyo*, **20,** 833–44 (1917).

Malay States

Anon.—Pottery Clays in the Malay States. *Bull. Imp. Inst.*, **14,** pp. 120–21 (1916).

Anon.—Report on the Occurrence of Various Kinds of Clays Including Supposed Kaolins. *Pottery Gaz.*, **42,** 11, 68 (1917).

Anon.—China Clay in Perak. *The British Clayworker*, **31,** 47 (1922–23).

Anon.—China Clay in Johore. *British Clayworker*, **32,** 95 (1923–24).

Jones, W. R.—Clays of Economic Importance in the Federated Malay States. (Abs. in *Bull. of Imp. Inst.*, **14,** 120–21 (1916).)

Scrivenor, J. B.—The Origin of the Clays and Boulder-Clays, Federated Malay States. *Geol. Mag.*, **5,** 157 (1918).

Scrivenor, J. B.—The Kaolin Veins. *Geol. Mag.*, **5,** 79 (1918).

Mauritius

Anon.—Local Clays for Brick and Tile Manufacture in Mauritius *Bull. Imp. Inst.*, **21,** 587–96 (1923).

Netherland Indies

Mohr, E. C. J.—Materials for Ceramic Industry in Dutch East Indies. *Ber. Afd. Handelsmuseum Kolonial Inst.*, No. 14, 12 pp. (1923).

Mom, C. P.—Vollersaarde. Het Voorkomen in Nederlandsch—Indië en de Eigenschappen, Inzonderheid het Oliekleurend Vermogen. Mededeelingen van het Laboratorium voor Agrogeologie en Grondonderzoek van het Algemeen Proefstation voor den Landbouw, No. 3, 1917. (Abs., *Geol. Centralb.*, **26,** 394 (1921).)

Mom, C. P.—Kaolin en Kwartszand. Grondstoffen voor Vuurvaste Steenen Glasfabricage in Nederlandsch Indië. Mededeelingen van het Laboratorium voor Agrogeologie en Grondonderzoek van het Algemeen Proefstation voor den Landbouw, No. 4, 1918. (Abs., *Geol. Centralb.*, **26,** 395 (1921).)

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI* (*cont.*), p. 386 (1901).

Van Amstel, G. E.—Chemical Investigations of some Clay Soils of Surinam. *Dept. Land. Surv., Bull.* **41,** p. 1921.

Seychelle Islands

Bauer, M.—Beiträge zus Geologie der Seychellen. *Neues Jahrb. f. Min.*, **2,** 163 (1898).

AUSTRALIA

General

Anon.—Australian Pottery Clay. *Bull. Imper. Inst.*, **19,** 465–8 (1921).

Anon.—Australian Pottery Clay. *Bull. Imp. Inst.*, **19,** 765 (1921).

Callister, R. C.—Australian Clays in the Manufacture of White Pottery Wares. *Australian Inst. Sci. and Indus., Bull.* **27** (1924).

Knibbs, G. H.—*Official Yearbook of Commonwealth of Australia, 1901–1919*, **13**, 481 (1920).

McMeekan, J.—Notes on Fire Bricks, Fire Clays and Other Refractory Materials. *Trans. of Inst. of Eng., Australia*, **1**, 380–7 (1921). (Abs., *Jour. Iron and Steel Inst.*, **107** [1], 611 (1923).)

New South Wales

Anon.—Analyses of Clays. Dept. Mines, N. S. W., *Ann. Rept.*, p. 53 (1890).

Anon.—Analyses of Clays. Dept. Mines and Agricult.; N. S. W. *Ann. Repts.: 1891*, pp. 59–61; *1892*, pp. 56, 57, 58, 60; *1893*, pp. 51–3; *1894*, pp. 61, 62, 65; *1895*, pp. 70, 73; *1898*, p. 79; *1899*, p. 204.

Anon.—Analyses of Clays. Dept. Mines, N. S. W. *Ann. Repts.: 1900*, p. 205; *1902*, p. 130; *1903*, p. 142; *1904*, p. 152; *1906*, p. 179; *1907*, p. 177; *1910*, p. 185; *1911*, p. 201; *1912*, p. 195; *1913*, p. 188; *1914*, p. 216; *1915*, pp. 194–7; *1916*, pp. 222–3; *1917*, pp. 177–8; *1919*, pp. 183–5; *1920*, p. 122.

Anon.—Report on Clays at Boxer's Creek. Dept. Mines and Agric., N. S. W., *Ann. Rept., 1899*, p. 189.

Anon.—Report on Clay at Ulladulla. Dept. Mines, N. S. W., *Ann. Rept., 1906*, p. 170.

Anon.—Pipe Clay, Pottery Clay, Kaolin, etc., in New South Wales. Dept. of Mines, N. S. W., *Ann. Rept., 1919.*

Cambage, R. H.—Clays. *Chem. Eng. Min. Rev.*, **15**, 317 (1923).

Card, G. W.—On Fullers' Earth from Wingen. *Records of the Geol. Surv., New South Wales*, **4**, Pt. 1, 30–2 (1894).

Carne, J. E.—Local Refractory Materials Used in Manufacture of Fire Brick. *Mineral Resources* (*N. S. W.*), No. **6**, pp. 168–84 (1899).

Carne, J. E.—Fire Brick and Pottery Clays. Dept. Mines, N. S. W., *Rept. on Geology and Mineral Resources of Western Coalfield, 1908*, pp. 237–40.

David, T. W. E.—Origin of the Laterite in the New England District of New South Wales. *Proc. Australasian Assoc. Adv. Sci.*, **1**, 233–91 (1899).

Dun, W. S.—Contributions to a List of Papers and Reports Dealing with the Economic Geology of New South Wales. (Bibliography of Clays.) *Records Geol. Surv. of New South Wales*, **6**, Pt. 4, 354–7 (1900).

Harper, L. F.—Report on White Clays near Blayney. Dept. Mines, N. S. W., *Ann. Rept., 1905*, p. 152.

Jaquet, J. B.—Report upon Clay Deposits at Boxer's Creek, near Goulburn. Dept. Mines, N. S. Wales, *Ann. Rept., 1899.*

Liversidge, A.—Clays. *Min. Resources N. S. Wales*, 193–5 (1888).

Mingaye, J. C. H.—Clays from New South Wales. Dept. Mines, New South Wales, *Ann. Rept., 1891*, p. 277–9 (1892).

Morrison, M.—Report on Pottery Clays. Dept. Mines, N. S. W., *Ann. Rept., 1918*, p. 160.

Pittman, E. F.—The Discovery of Bauxite. Dept. Mines, N. S. Wales, *Ann. Rept., 1899* (1900).

Pittman, E. F.—Clays of New South Wales. *Min. Resources New South Wales*, pp. 432–6.

Plummer, John.—Bauxite in New South Wales. *Eng. and Min. Jour.*, **73**, 763 (1902).

Raggatt, H. G.—Fullers' Earth. N. S. W. also Dept. Mines, *Geol. Surv., Bull.* **14**, 15 (1924).

Smith, H. G.—On Kaolinite from Hawkesbury Sandstone. *Jour. Proc. Royal Soc. New South Wales, 1891*, **25**, 171–8 (1891).

New Zealand

Anon.—China Clay in New Zealand. *Jour. Ind. and Eng. Chem.*, Sept., 1915.

Director of Sci. and Tech. Dept. of the Imp. Inst. London.—Report on Clay from the Harokiwi Valley. *New Zealand Mines Record*, **5**, 383 (1901–02).

Binns, G. J.—Clays and Sands (in N. Zealand). *Trans. Federated Inst. Min. Eng.*, **4**, 77 (1893).

Howe, J. A.—A Handbook to the Collection of Kaolin, China Clay and China Stone. *Handbook Mus. Proc. Geol.*, p. 108 (1914).

Jameson, A. B.—The Technical Analyses of Auckland Clays. *New Zealand Jour. Sci. Tech.*, **2**, 209–19 (1919).

Morgan, P. G.—Clay and Fullers' Earth. *New Zealand Jour. Sci. Tech.*, **2**, 119 (1919).

Rowe, H. V.—A Systematic Examination of the Refractory Clays of the Canterbury District, with Special Reference to their Use for Fire Bricks and Furnace Linings. *New Zealand Jour. Sci. Tech.*, **1**, 4 (1918).

Queensland

Anon.—Queensland China Clay. *The British Clayworker*, **15**, 209 (1906–07).

Anon.—Clays. *Board of Trade Jour.*, **65**, 343. (Abs. in *Jour. Iron and Steel Inst.*, **80** [2], 348 (1909).)

South Australia

Anon.—Clay in South Australia. *British Clayworker*, **12**, 361 (1903–04).

Anon.—*A Review of Mining Operation in South Australia, No. 9, 1908.* P. 48 (1909) and *op. cit. No. 13, 1910*, p. 23 (1911).

Jack, R. L.—Fire Clay in South Australia. *Rev. Min. Oper., South Australia*, **26**, 1917. (Abs. in *Imp. Inst. Bull.*, **16**, 119 (1918).)

Ward, L. K.—Report on the Clays Worked by the Longwood Tessellated Tile Co., Ltd., at Longwood. S. Australia Dept. of Mines. *Mining Review*, **32**, 38–40 (1920).

1———Scattered Notes Including Analysis in Annual Report of Director of Mines and Government Geologist for 1916, pp. 9, 11–8. Also in the *South Australia Mining Review* as follows: No. 20, p. 34; No. 24, pp. 51–2; No. 26, pp. 38–41; No. 32, pp. 38–40; No. 33, pp. 46–7; No. 39, pp. 54–8.

Tasmania

Twelvetrees, W. H.—Report on Clay Deposits at St. Georges Bay, Tasmania. Government Printer, 10 pp.

Victoria

Anon.—Kaolin near Lintons in Argyle. Secretary for Mines, Melbourne, Victoria. *Annual Report.*

Anon.—Clay Deposits of Victoria. *The British Clayworker*, **15**, 181 (1906–07).

Anon.—Australian Pottery Clay. Pottery Clay from Bendigo Victoria. *Bull. of Imp. Inst.*, **21**, 321–4 (1923).

Callister, R. C.—Porcelain Clays of Ballarat. *Chem. Eng. Mining Rev.*, **15**, 36–43 (1922).

West Australia

Campbell, W. D.—Clay Deposits of the Clackline District. Geol. Surv. W. Austral., *Ann. Rept. Prog., 1906*, pp. 24–5 (1907).

Feldtmann, F. R.—Clay Deposits at Three Springs. Geol. Surv., W. Austral., *Ann. Rept. Prog., 1918*, pp. 32–3 (1919).

Feldtmann, F. R.—Clay Deposits at Mount Kokeby, Southwest Division. Geol. Surv., W. Austral., *Ann. Rept. Prog., 1918*, p. 33–5 (1919).

Feldtmann, F. R.—The Clay Deposits of Bolgart, Southwest Division. Geol. Surv., W. Austral., *Ann. Rept. Prog., 1919*, pp. 27–9 (1920).

Feldtmann, F. R.—The Clackline and Baker's Hill Clay Deposits, Southwest Division. Geol. Surv., W. Austral., *Ann. Rept. Prog., 1919*, p. 29–30 (1920).

Homan, C. S.—The Extension of the Kelmscott Clay Deposit. Geol. Surv., W. Austral., *Bull.* **48,** p. 63–5.

Larcombe, C. O. G.—The Geology of Kalgoorlie. *Trans., Australasian Institute of Mining Eng.*, **14,** 182, 257 (1912).

Simpson, E. S.—Fire Clay at West Collie (Moira) Colliery, Collie Coalfield. Geol. Surv., W. Austral., *Bull.* **6,** p. 58 (1902).

Simpson, E. S.—Clays at Newlands. Geol. Surv., W. Austral., *Ann. Rept. Prog., 1906*, p. 28–9 (1907).

Simpson, E. S.—Clays (Tables of Analyses). Geol. Surv., W. Austral., *Bull.* **67,** 104–7, 116, 117 (1916).

Simpson, E. S.—Clays. Geol. Surv., W. Austral., *Ann. Rept. Prog., 1918*, p. 35 (1919).

Simpson, E. S.—Clays. Geol. Surv., W. Austral., *Ann. Rept. Prog., 1919*, p. 35 (1920).

Simpson, E. S.—Clays. Geol. Surv., W. Austral., *Ann. Rept. Prog., 1920*, p. 21 (1921).

Simpson, E. S.—Clays. Geol. Surv., W. Austral., *Ann. Rept. Prog., 1921*, p. 52 (1922).

Simpson, E. S.—The Mineral Resources of Western Australia. *Folder No. 2*, pp. 13–5 (1924). (Compiled for British Empire Exhibition.)

Woolnough, W. G.—The Physiographic Significance of Laterites in Western Australia. *Geol. Mag.*, **5,** 385–93 (1918).

AFRICA

Algeria

Granger, A. and Brémond, P.—The Chemical Composition of Rock Known as the Kaolin from Djebel-Debar (Algeria). *Comptes Rendus,* **175,** 36–8 (1922).

Parran, A.—Sur les Terrains de Gneiss des Environs de Bône. (Kaolin.) *Bull. Soc. Géol. France,* p. 509 (1883).

British Somaliland

Anon.—Clay from British Somaliland. *Bull. Imp. Inst.*, **22** [1], 66 (1924).

East Africa

Anon.—The Manufacture of Tiles in East Africa. *Bull. Imperial Inst.,* **19** [3], 297–311 (1921).

Egypt

Banks, E. J.—Clay Products of Babylonia. *The Clayworker,* **47,** 58–60 (1907).

Guinea

La Croix, A.—Les Laterites de la Guinée et les Produits d'Alteration qui leur sont Associatés. *Nouv. Arch. du Musée,* **5** [5], 255–356 (1914).

German East Africa

Anon.—Kaolin. Economic Resources of the German Colonies. *Bull. Imp. Inst.,* **12** [4], 598 (1914).

Gold Coast

Kitson.—Mineral Resources of Gold Coast. *Min. Mag.,* 1925.

Madagascar

Bauer, M.—Beitrag zur Kenntnis des Laterits, insbesondere dessen von Madagascar. *Neues, Jahrb. für Min. Geol. u. Pal., Festband,* 33–90 (1907).

Lacroix, A.—Sur la Kaolinite Cristallesèe de Nossi-Bé. *Bull. Soc. franc. Min.,* **24,** 34–5 (1901).

La Croix, A.—Les Produits des Roches Silicates et Alumineuses, et en Particulier les Laterites de Madagascar. *Compt. rend.,* **159,** 617 (1914).

Mozambique

Holmes, A.—The Lateritic Deposits of Mozambique. *Geol. Mag.,* **1** [6], 529–36 (1914).

Natal

Anon.—Kaolin Deposits in Natal. *The British Clayworker,* **17,** 219 (1908–09).

Nigeria

Anon.—China Clay Analyses. *Tonind. Zeit.,* **25** [46], 672 (1901).

Anon.—Tile and Brick-Making materials of Nigeria. *Bull. Imp. Inst.,* **21,** 302–10 (1923).

Rhodesia

Anon.—Mineral Resources of Rhodesia. Bulawayo 1910, *9th Annual Report Rhodesian Museum,* pp. 35–60.

Mennel, F. P.—Notes on Rhodesian Laterite. *Geol. Mag.,* **6,** 350–2 (1909).

Sierra Leone

Dixey, F.—Notes on Laterization in Sierra Leone. *Geol. Mag.,* **57,** 211 (1920).

South Africa

Adams, J.—Clays of South Africa. *The British Clayworker,* **27,** 122 (1918–19).

Adams, J.—The Manufacture of Ceramic Wares in the Union. *Pretoria South Africa Jour. of Industries,* p. 763 (1918).

Anon.—China Clay in Capetown. *British Clayworker,* **8,** 71 (1904–05).

Anon.—Raw Materials for the Ceramic Industry in South Africa. *Bull. Imp. Inst.,* **18,** 271–9 (1920).

Anon.—Brick Making in South Africa. *British Clayworker,* **31,** 91 (1922).

Rogers, A. W.—Occurrence of Diaspore in the Transvaal on Mooikopje, 58, Middleburg. *Trans. Geol. Soc. S. Afr.,* **27,** 71–5 (1924). Analyses of kaolinite and diaspore.

Wagner, P. A.—Fire Clay in Olinfantsfontein. *Trans. Geol. Soc. S. Africa,* **19,** 36 (1916). (Abs. in *Bull. Imp. Inst.* p. 288 (1917).)

Uganda

Anon.—Pottery Clays from Uganda. *Bull. Imp. Inst.,* **22** [3], pp. 296–303 (1924).

PACIFIC OCEAN ISLANDS

Hawaiian Islands

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** p. 301 (1897).

New Caledonia

Davis, W. M.—Metalliferous Laterites in New Caledonia. *Proc. Nat. Acad. Sci.,* **4,** 275–80 (1918).

Philippine Islands

Cox, A. J.—The Occurrence, Composition and Radioactivity of the Clays from Luzon, Philippine Islands. *Phil. Jour. Sci.,* **2A** [6], 413. (Abs., *Geol. Centralb.,* **11,** 215 (1908).)

Cox, A. J.—Laguna Clays. *Philippine Jour. Sci.,* **3** [5] (Sec. A., General Science), Nov. (1908).

Growe, C. H.—Philippine Clay Work. *The Mineral Resources of the Philippine Islands for the Year 1911,* p. 97. (Abs., *Geol. Centralb.,* **21,** 199 (1914–15).)

ACTIVITIES OF THE SOCIETY

THE FALL MEETING

Grand Central Palace, Thursday, October 1
Ceramic Day at Chemical Exposition

The general theme—shall ceramic products, their properties, specifications and service requirements be stressed more in collegiate ceramic courses.

A lively and worthwhile list of speakers are preparing papers, E. Ward Tillotson, Frank H. Riddle, Alexander Silverman, Charles W. Hill, Amos P. Potts, Frederick H. Rhead, Hewitt Wilson, W. K. McAfee and R. D. Landrum. Other speakers are assured but definite assignments and acceptances have not been registered at the time of going to press (Aug. 18).

A joint dinner has been planned for the evening of October 1 at Hotel Commodore with the several chemical societies. Eminent industrialists will be speakers. Detailed announcements will be issued by card.

NEW MEMBERS RECEIVED FROM JULY 15 TO AUGUST 15

PERSONAL

Holland R. Bacher, Rock Tavern, N. Y. President, White Cloud Farms, Inc.

Mathew M. Braidech, Jr., Y. M. C. A., Pittsfield, Mass. Chemical Engineer, General Electric Co.

J. B. Fauchon, Paray-le-Monial (S. & L.), France.

Frank G. Gibson, Malvern, Ohio.

A. C. Harrison, 1791 Lanier Place, Apt. 42, Washington, D. C. Junior Scientist, Bureau of Standards.

Gustav Hoppe, Belgrad, Terarije 14, Jugoslavia.

Gordon C. Keith, Secretary, Canadian National Clayworkers Association, 51 Wellington St., Toronto, Ont., Canada (Honorary Member).

Charles E. Miller, Darlington Brick & Mining Co., Darlington, Beaver Co., Pa.

David W. Miller, Ironton Fire Brick Co., Ironton, Ohio. Ceramist.

Lemon Parker, Parker-Russell Mfg. Co., St. Louis, Mo.

Colin Presswood, General Refractories Co., Ltd., 28 Blonk St., Sheffield, England.

Hugo Wilisch, Konigswinter, Rhine, Germany.

CORPORATION

Central of Georgia Railway Co., Savannah, Ga. J. M. Mallory, General Industrial Agt.

Membership Workers' Record

	Personal	Corporation
C. E. Bales	1	
G. A. Bole	1	
C. F. Geiger		1
R. F. Geller	1	
F. G. Jackson	1	
George Simcoe	1	
F. C. Woodside	1	
Office	6	
	12	1

MISS SHEERER RETURNS FROM PARIS

Miss Mary G. Sheerer, Chairman of the Art Division, has returned from Paris where she attended the International Exposition of Modern Decorative and Industrial Arts. Miss Sheerer was appointed as a delegate by Herbert Hoover, Secretary of Commerce of the United States. A report of this Exposition follows below.

PERSONAL NOTES OF MEMBERS

A. I. Andrews, who has for the past year been Professor of Ceramic Engineering at Alfred University, has accepted a position at the University of Illinois as Assistant Professor of Ceramic Engineering. Previous to his association with Alfred University Dr. Andrews was employed at the Ceramic Station of the U. S. Bureau of Mines, his chief investigation being on dolomite refractories.

Dr. Andrews received his B.S. and M.S. in chemistry at the University of Wisconsin and Ph.D. at Ohio State University in 1924.

VISIT OF THE DELEGATION OF AMERICAN LUXURY INDUSTRIES TO THE INTERNATIONAL EXPOSITION OF MODERN DECORATIVE AND INDUSTRIAL ARTS, PARIS 1925

By Mary G. Sheerer

As a member of this delegation it is my pleasure to send an account of this important visit to Paris to the Art Division of the American Ceramic Society.

A Commission of four men, with Charles R. Richards as Director, was appointed by Herbert Hoover, United States Secretary of Commerce, to visit and report on the Exposition.

The Commission sent out notices to this effect urging the industries and craft societies to send delegates to assist with the report. There were about 125 delegates, including interior decorators, furniture and other household manufacturers, textile, wrought iron, stained glass designers and makers, architects and representatives from arts and crafts societies.

Wishing, as Chairman of the Art Division, to get more in touch with the industries and feeling sure that Paris and its Exposition had a message for us in America, I went over to attend the meetings of the Commission and to visit the Exposition with them.

Mrs. Adelaide Robineau was another representative of the pottery craft and Mr. Holmes of the Lenox Belleek was one of the four Commissioners.

The objective of the Commission may best be given by quoting from the program arranged by the French and American committees.

As presented by L. P. Sézille, a leading architect of Paris and the Exposition and a member of the French Committee of Entertainment, the object was:

"1. To acquaint the delegates of the United States of America with the extent of the French effort as applied to all branches of modern decorative art.

"2. To arouse interest on the part of the delegates in our modern creations with a view to achieving practical commercial results between the United States and France.

"To attain this end a program should be drawn up embodying a dual selection: first, a selection of aesthetic order, grouping purely beautiful works; second, a selection conforming with American psychology.

"As a matter of fact due account should be taken of:

"1. The infatuation of Americans for classical works established by tradition.

"2. The normal reaction of connoisseurs of exclusively antique art who will mercilessly draw attention to the defects of certain modern works.

"3. The visitors' difficulty in adapting themselves to certain formulas with which the French are already familiar, whereas we are not.

"The initial effort should, therefore, be directed toward convincing the American delegates of the fact that, side by side, with works whose commonplace or eccentric character has been purposely exaggerated, there exist productions which are so well balanced that they may rank with time-honored works of antique style which, on their part, form the selection made by taste and time from efforts comparable to those of our epoch.

"(It would have been desirable in this connection to have found it possible to introduce the delegation into the homes of some famous collectors who, side by side with catalogued works of art, have made place for a few fine examples of the work of modern decorators; but the time allowed does not appear sufficient to enable this plan to be considered.)

"In the limited time (13 visits of an average of two hours) which the delegation can devote to this study, 'courses and lectures' cannot be contemplated. The works themselves, without any preparations, must win the cause.

"For this very reason the program must confine itself to such modern products as are sufficiently near classical forms to be understood and accepted.

"Later on, if we are fortunate enough to win this 'first lap,' a time will come when our American friends may take an interest as we do in all vanguard efforts without our having to fear a failure which at this time would be detrimental to the interests of France."

In detail the general program reads:

1. Visits to the Exposition of decorative art
2. Visits to decorators' plants and showrooms
3. Visits to the schools and manufactories .
4. Visits to public institutions and industrial and private buildings

Constituting a cycle which will demonstrate:

1. The development of modern production on the part of artists and manufacturers.

2. The organization of a system of tuition preparing the continuity of the tendency toward modernization.

3. The adaptation of new formulas to the requirements of modern life.

Division of time: five visits to the Exposition; eight visits elsewhere.

Besides this comprehensive program, there were numerous receptions, luncheons, banquets and gala occasions given by the French Government, the Commissioner General of the Exposition, the Baron and Baroness Rothschild and the beautiful fête at Versailles.

The first visit to the Exposition included the ceramics and glassware of the luxury industries, details of which I shall give in another article.

Another visit was to the French Artisan Pavillion, which was largely devoted to the group of artist-craftsmen who lead the way in advancing the taste of the times, and whose work is reflected and made popular by the manufacturers.

The earthenware, stoneware, porcelains and glassware of the French artisans, together with similar work by the Danish, Swedish and English in the Grand Palais, was the pulse of the ceramic household arts to me.

It is among the artisans that we must look for fresh impulse and for an individual

expression of art in one medium or another. When their influence has been sufficiently felt by the schools, it is reflected by the manufacturer and the taste of the public is advanced. Parenthetically, let me say, that I hope the next step on the part of the museums will be to encourage the artisan by special exhibitions of his work as a few museums are now doing for the manufacturers. Both the manufacturer and the artisan reach our home life at every turn and are a powerful factor in making or marring our sense of beauty.

Simplicity of form and decoration characterize the best work at the Exposition, with quality of surface whether stoneware or glazed pieces, a prominent feature.

Some of the newest table ware made to harmonize with the modern furniture is of a cream white, with flowers cut and modeled in the wet clay without any change of color. A set of this kind was very effective on a table and sideboard of Chinese red lacquer and ivory knobs and harmonized with the straight lines of the furniture.

I shall have another detailed article of some of the ceramic household arts at the Exposition.

NOTES AND NEWS

NEW RULING IN A. A. A. S.

On account of the recent affiliation of the American Ceramic Society with the American Association for the Advancement of Science, all members of the Society who are not already members of the Association are now entitled to the special privilege of becoming members of the Association without paying the usual five-dollar entrance fee. This privilege has been extended till January 1, 1926, when it will automatically come to an end. Information about the American Association and sample copies of its journals may be secured from the office of the Permanent Secretary of the Association in the Smithsonian Institution Building, Washington, D. C.

BIBLIOGRAPHY OF BIBLIOGRAPHIES

On Chemistry and Chemical Technology 1900–1924

In a Bulletin compiled by Clarence J. West and D. D. Berolzheimer for the Research Information Service of the National Research Council are 308 pages of listings of bibliographies on chemistry and chemical technology. To prepare a bibliography of bibliographies of this size was a task so large there is no reason to wonder why it is not more exhaustive. The authors deserve unstinted praise. They have given chemists and chemical technologists a reference library which no ceramist can afford to be without.

Quoting in part their introduction: "As a rule bibliographies are not issued as separate publications but are found as footnotes or appendices to books and to articles in the various scientific publications. Although a few of these lists may be located through abstract journals or through the bibliographical entries on the Library of Congress cards, most of them are not to be discovered by consulting the ordinary sources of information available to the research worker."

This bibliography is divided into five parts, (1) list of general bibliographies, (2) list of general abstract journals and year books, (3) partial lists of collective serials, (4) bibliographies on special subjects, and(5) list of personal bibliographies.

The bibliographies of special interest to ceramists cover (1) abrasives, (2) aluminum compounds among them the silicates, (3) bauxite, (4) bentonite, (5) boracic acid, borax and borates, (6) brick, (7) calcium and calcium compounds, (8) calorimetry, (9) carbides, (10) cement, (11) ceramics, (12) chromium, (13) clay, (14) coal, (15) cobalt, (16) colloids, (17) color and colorimetry, (18) copper, (19) corundum, (20) dental cements, (21) dolomite, (22) drying, (23) enamels, (24) feldspars, (25) fluorspar, (26) glass, (27) glass sands, (28) gypsum, (29) electric insulation, (30) iron and iron compounds, (31) kaolin, (32) Kieselguhr, (33) lead and lead compounds, (34) leucite, (35) magnesium and magnesium compounds, (36) manganese and manganese compounds, (37) mica, (38) minerals and mineralogy, (39) nickel and nickel compounds, (40) phosphates, (41) plasticity, (42) porcelain, (43) potash and potash compounds, (44) quartz, (45) refractories, (46) rutile, (47) sand lime brick, (48) selenium and selenium compounds, (49) silica and silicates, (50) silicon, (51) sodium and sodium compounds, (52) thermo properties, (53) tin, (54) titanium, (55) viscosity, (56) zeolites, (57) zinc and zinc compounds, (58) zirconium.

Price $2.50. Orders accompanied by remittance should be addressed to Publication Office, National Research Council, Washington, D. C.—Editor.

NEW CERAMIC ENGINEERING COURSES OFFERED BY CORRESPONDENCE

North Carolina State College, Raleigh, announces that a sufficient number of students have registered in the following correspondence courses in Ceramic Engineering to make them immediately available.

Cer. E.—102 Physical Geology. Fee $5.00
Cer. E.—103A Occurrence and Properties of Clays. Fee $7.50
Cer. E.—208D Pyrometry. Fee $2.50

The course in Physical Geology is a beginning course in Geology designed to prepare a student for the study of clays. The course includes several lectures on Historical and Economic Geology.

The course in Occurrence and Properties of Clays gives the student a complete set of lectures on this subject, a knowledge of which is so essential for the proper understanding of the various clay working processes.

The course in Pyrometry is probably the most complete set of lectures on the subject of Thermometry and Pyrometry that has ever been offered. Every phase of these subjects from the invention of the first thermometer to the modern pyrometer installations of the present day is completely covered. This course will be found of great value to all those dealing with temperature control, whether connected with the ceramic or other industries using heat processes.

It is the intention of Professor A. F. Greaves-Walker to prepare additional courses as fast as the demand is presented. Eventually it is anticipated that practically the entire ceramic field will be covered.

Bulletin will be sent upon request.

CALENDAR OF CONVENTIONS

Organization	Date	Place
Am. Assn. Advancement of Science	Dec. 28–Jan. 2	Kansas City, Mo.
AMERICAN CERAMIC SOCIETY		
(Annual Meeting)	Feb. 8–13, 1926	Atlanta, Ga.
(Fall Meeting)	Oct. 1, 1925	New York City

Organization	Date	Place
Am. Electrochemical Society	Sept. 24–26, 1925	Chattanooga, Tenn.
Am. Engineering Council	Jan., 1926	
Am. Foundrymen's Association	Oct. 5–9, 1925	Syracuse, N. Y.
Am. Gas Association	Oct. 12–16, 1925	Atlantic City, N. J.
Am. Inst. of Min. and Met. Engineers	Aug. 31–Sept. 5, 1925	Salt Lake City, Utah
Am. Soc. of Mechanical Engineers	Nov. 30–Dec. 3, 1925	New York City
Am. Zinc Institute	April 27–28, 1926	St. Louis, Mo.
Assn. Iron and Steel Elec. Engineers	Sept., 1925	Philadelphia, Pa.
Coal Mining Institute of America	Dec. 9–11, 1925	Pittsburgh, Pa.
Common Brick Manufacturers Assn.	Feb. 22–26, 1926	New Orleans, La.
Mining and Met. Society of America	Jan. 12, 1925	New York City
Natl. Association of Manufacturers	Oct. 26–28, 1925	St. Louis, Mo.
Natl. Brick Manufacturers Assn.	Nov. 2–7, 1925	St. Louis, Mo.
Natl. Exposition of Power and Mechanical Engineers	Nov. 30–Dec. 5, 1925	New York City
Natl. Exposition of Chem. Industries	Sept. 28–Oct. 3, 1925	New York City
Natl. Paving Brick Mfrs. Assn.	Jan., 1926	
Natl. Safety Council	Sept. 28–Oct. 2, 1925	Cleveland, O.
Optical Society of America	Oct., 1925	Ithaca, N. Y.
Sand-Lime Brick Association	Feb. 9–15, 1926	New Orleans, La.
Natl. Society for Vocational Education	Dec. 3–5, 1925	Cleveland, Ohio
Natl. Exposition of Coal Mining Machinery	Dec. 2–5, 1925	Cincinnati, O.

BULLETIN
of the
American Ceramic Society

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

Vol. 4 October, 1925 No. 10

EDITORIALS

CERAMIC EDUCATION

While preparing copy for this number of the *Journal* a new type of ceramic school is getting under way in East Liverpool and while this number of the *Journal* is in the mail members of this SOCIETY will be in conference in New York City on the question whether products and product requirements should be given more stress in the collegiate ceramic courses. During the past year Professor Greaves-Walker has gotten under way a correspondence course in ceramics. In the current literature there has been the suggestion that much of the inadequacy in American ceramics is traceable to lack of training and personal skill in the science and art of producing wares. University extension in ceramics has in some measure met the longing of many for aid in self equipment to serve better industrially, and aid in self expression in clay, glass and vitreous enamels; a longing born of a realization of deficiencies in ceramic processing and in ceramic products.

The Trenton Art School under Professor Fredericks, and other schools of like intent but with less facilities and support, have contributed quietly, but with sure results, in awakening a personal desire for more ability to produce finer quality and more artistic wares. Skill acquired in the collegiate and in the summer training courses in ceramic science and art conducted by Dr. Charles F. Binns at Alfred University con-

tinue to ripple on through the ceramic work of his pupils in the several art schools and regular day schools throughout the land, impressing not only the surface but also the depths of the demand and supply for more expressive and better wares. The ceramic art courses in Tulane University, Lewis Art Institute and in the several museums, and lately in Syracuse University and other institutions, are having a profound yet little realized effect on the ceramic purchasers and producers, individually and collectively.

The general question of the "how and what" of ceramic instruction is a natural outcome of the work already done by ceramic schools and is evidence of a growing need of the schools giving a close, open-minded study of how to produce distinctive wares economically. Schools must be as forward looking as any institution and particularly must they keep ahead of the heavy swells and back wash produced by their own propelling force. Ceramic schools and educational schemes are multiplying because students from the present schools have proven the value of special training and study. The present unusual and constantly increasing demand for better and less costly wares is one of the back washes of ceramic schooling.

Ceramic wares may be distinctive in the manner they meet service conditions or in the degree they satisfy and beautify; and schools cannot effectively train youths in methods of advancing ceramic technology and art unless the instructors search, experiment and explore the unsatisfied service and decorative needs.

The Art-in-Trades Club, the Art Division of this SOCIETY, the Metropolitan Museum, the Architects Leagues and Clubs of this country obtained new and larger visions at the Exposition Des Arts Decoratifs recently held in Paris and reported in the September number of this *Bulletin*. Each of these several groups has plans already for advancing the art quality in industrial products; awards and money prizes have been provided to excite individual and collective efforts.

Secretary Hoover has led in awakening researches in industrial waste of materials and labor, and in reduction of varieties and increase in quality of utility wares. Industrial associations and purchasers are in active accord with Hoover's program, all of which is reflected in the character, quality and definiteness in the activities of trade and technical societies and of the federal bureaus, state universities and technical institutes. Engineering experiment stations at several universities, with large sums invested in buildings, equipment and staff are in answer to this general-felt need for more economical production and more suitable product.

The employment this summer of the entire instructional staff with student laborers at University of Illinois Ceramic Department on industrial researches, making application to definite industrial problems the

facts revealed by scientific researches, is the sort of close working relation there must be between ceramic schools and the industries if the schools are to be up-to-date effective. School laboratories which are idle and school instructors who recreate for three or more months each year are not performing economically nor effectively, nor are they keeping up with the increasing demands for investigational and educational services. The schools have started something which will leave them discredited in their own wake unless their productiveness increases with their increasing demands. State and federal aids and industrial coöperation can be had in support of any and all educational enterprises which will enable manufacturers to get abreast more surely and more quickly with the increasing demands for more serviceable and more artistic ceramic wares. The several educational schemes for both intensifying and broadcasting educational means should be carefully studied by the schools.

NOTES ON CERAMIC ENGINEERING EDUCATION

By Hewitt Wilson[1]

A summary of most of the suggestions, objections and criticisms of ceramic engineering education now given in the several universities of the country is as follows:

1. The ceramic courses should be arranged to produce graduates who are better fitted to manufacture wares for definite purposes, and that products and product testing should be emphasized in preference to materials and materials mixing and testing.
2. That the ceramist needs training in "form, color and design."
3. That graduates should be better equipped to "anticipate service and market demands."
4. That the graduate should have more mechanical training in clay plant machinery. Too much time is now spent on glazed pottery.
5. That he should be given courses in psychology for executive positions and to handle labor.
6. That more attention should be paid to "factory management, including process control and human relations."
7. That more provision should be made for "elective courses in department of architecture, civil engineering, art and commerce. . . .to acquaint the graduates with the problems in the use and disposition of ceramic materials."
8. Suggestions for discussion are also made on the subjects of: courses, correspondence courses, radio lectures, preparation of texts, vocational training, etc.

---

[1] Director Department of Ceramics, Univ. of Washington, Seattle, Wash.

At times, the discussion reminds us of the fable of the man, his boy and the donkey. They tried to please everyone along the market road by different methods of locomotion and ended their journey by carrying the donkey and pleasing no one. The structural products manufacturer wants a mechanical engineer with a veneering of ceramics of the fuel and combustion type; the terra cotta manufacturer wants a good glaze and color man; the pottery manufacturer who has developed his body and glazes wants a control engineer, artist or salesman; the enamel, glass and cement manufacturer wishes a chemical engineer for control by analytical methods and the refractory manufacturer must have a man skilled in high temperature products and testing.

In the past most of the ceramic schools have not been able to fill the demands or orders for graduates of general qualifications. In the past 20 years the qualifications have changed from time to time. In the early days, a greater demand was made for ceramic men to work in brick, tile and sewer pipe positions. Later, the terra cotta companies needed men trained in glaze and color work. It was not until the war period that the potteries wanted technically trained men for whiteware body and glazing problems. Now the refractory manufacturer needs research men for the specialized refractories. And with each demand for new qualifications have come the "repeat orders" from the other industries. Chemical engineers have taken a large percentage of the enameled metal, glass and cement positions, for these industries are more dependent on analytical control than the clay industries. With the cry raised for more attention to be paid to products and their disposal, it would seem that the manufacturing problems, save those of the control type, have approached solution. However, from the magnitude of the work on raw materials now under way in the U. S. Bureau of Mines, the Mellon Institute and even the Bureau of Standards, it is apparent that we are only nicely started on the fundamentals of our ceramic raw materials and methods of mixing, treatment and purification.

Present day ceramics is a wide and varied field of industry. No school can take a high school graduate and in four years give him a thorough grounding in chemistry, physics, mathematics and detailed studies, with accompanying laboratory work, in structural products, pottery, refractories, glass, cements, limes, plasters, enameled metals, insulation products and abrasives. It should also be remembered that the graduate is usually an immature boy, who must season awhile in the commercial atmosphere before he can become a very important or even a functioning part of the factory organization. Even in the less varied and more specialized electrical and mechanical branches of engineering, the larger manufacturing organizations give the graduate a six-month to a year training in special plant schools before they try to place them. The de-

mand in those organizations is for the fundamentals. They say, "We will give them the polishing. Do not try to crowd too much into a four-year ceramic course."

If all the suggestions noted at the beginning of this letter were to be given proper attention, it would be necessary to expand the ceramic department into a College of Ceramics with at least the four following options: (1) Ceramic Plant Engineering for the structural products, refractories, abrasives, etc.; (2) Ceramic Chemistry for enameling, glass, glazes and cement, and general chemical control; (3) Ceramic Art and Architecture for the artistic side of all the decorated wares and (4) Ceramic Marketing for salesmen, executives and business control. Each state university provides enough subjects in the other colleges or departments besides that of engineering to insure a well-rounded curriculum in each of the above options if the first two years were devoted to the engineering fundamentals. But the four options should not be lumped into one four-year course. The Illinois and New York schools have already divided their work into two options, but from the character and magnitude of the recent suggestions, one division does not yet appear to have solved the problem.

At the present time, the ceramic graduate does not know until the last month or minute, what kind of work he will enter. Our ceramic schools need better coöperation from the prospective employer (who is the consumer of the schools' product) if the manufacturer's interests are to be best served. Why cannot the manufacturer prepare and plan in advance for this most important raw material? If he sees a future need for one or more ceramic graduates, he should first get acquainted with the school and then from the junior or sophomore class pick out the type of individual he desires. If this student knows that he is associated with a certain organization which specializes in certain products, he will have a better incentive for his class and laboratory work. His thesis and all individual recitations and laboratory problems can be devoted to this direction. He will select his electives with the advice of his future employer and can spend his summer vacations in the direct employ of the manufacturer. The transition from school to factory will then be gradual. The alternative method places the responsibility of the specialized work on the student himself with the advice of the ceramic instructor. If any specialization is to be permitted, this is the opportunity for the manufacturer to state his requirements to individual students.

Emergency cases will have to be treated in a different way. The employer should pay for encountering an emergency without having planned for it. If he wishes to employ a graduate with the fundamentals and without special training in his industry, he then must do the extra training in his own factory or, as soon as convenient, pay for the specialized

education of the young man as a graduate student at a school where this specialty is understood.

This present agitation for investigation into ceramic education is long overdue. The ceramic instructor has for some time wanted the delayed coöperation of the manufacturer to avoid the last minute rush-order demands for graduates. If he has knowledge of the type of work the student will be expected to perform when he leaves school, he can give him many valuable coaching hints to tide over the transition period. But the plant manager should coöperate by forecasting his demands for technical employees at least for the same length of time he stocks other valuable raw material.

Products versus Materials

The direct criticism of the ceramic engineering schools because they do not spend more time with products and less with materials is premature. What has the ceramic industry known up to the present time about specifications and methods of testing finished products? Very little until it was awakened by competitive materials to the realization *that it thought it knew but couldn't put it on paper.* The common brick people are still asking the question, "What is a brick?" And a large number even with specifications are not trying to improve an inferior product. The terra cotta industry has been coöperating for seven or eight years with the U. S. Bureau of Standards in trying to write specifications for their product but they will not send any progress reports of this work to the ceramic schools to enable the instructors and students to follow the investigation. And the ceramic instructor has no data for specifications of terra cotta products unless he has some contact with the industry and can get the report in a roundabout way. This is a plain case of lack of interest in educational coöperation on the part of the terra cotta industry. On the other hand the refractory industry has been very frank about its troubles in deriving specifications and I do not believe that you will find a ceramic school which has not included in its regular course, studies on the compounding of refractory bodies to meet these specifications, together with the testing of products from commercial factories. Specifications are now being completed on pottery and other products which will be available for ceramic instruction next year and you will find that the schools will not be negligent in using them. On the other hand, consider the lack of specifications of our raw materials. And for that reason we believe that this recent criticism is premature.

Every ceramic instructor is worked to capacity during the school period and has practically no chance for research work in any line. During the summer time, unless he is employed by government agencies for research work, he is trying to make expenses by working on problems of another's selection.

It is true that the cement interests get far more advertisement in the engineering colleges than do the clay product organizations. This is because the cement interests have offered more coöperation. First, they have been united in their efforts for a long time, then they have studied their materials and associated products very thoroughly and have developed the use of their wares on an engineering basis and have assembled the data in an engineering way to enable the engineering instructor to readily impart it to his class and to use it for all types of problems dealing with structural materials. Similar work has not been done by the clay products associations who are younger and have not realized, until the present, the advantages of united research plus coöperation with the young men in the colleges. The Portland cement interests have passed the material studying and testing stage and for many years have devoted most of their time to products, products testing and sales exploitation. However, they have had an easier problem in material assembling and could apply chemical control methods to their manufacturing processes. As far as the writer knows, the Portland cement people have not been interested in the ceramic schools and have developed their manufacturing processes by others than ceramists. The introduction of new types of cementing materials into the market will draw their attention to materials again. The above illustration shows that the lack of interest in engineering circles to clay products cannot be properly laid at the door of the engineering or ceramic instructor who is primarily a teacher and not a research man. He must for the most part depend upon the industries themselves for the engineering facts about their products. Such facts will be readily assimilated by engineering curricula and will be assigned relative positions based upon their engineering importance as fast as they are collected and proven.

Such data have long been desired by the ceramic instructor. It has been awkward for him to develop a ceramic product from the raw materials to the finished state and then tell the class that according to the present knowledge it has value but that no engineering specifications have been devised for accurately placing it.

I do not wish to infer that clay wares are not tested in the laboratory as part of the student work. At the University of Washington (Seattle) a considerable part of our time has been spent in coöperation with the local industries by the testing of refractories, terra cotta, structural wares and pottery. But we have not had the coöperation from the national industries with national industrial research to determine the degree of perfection of these tests. We have progressed as far as any other laboratory of its size in devising methods of testing refractories and are now developing a fire brick spalling test with student help. However, the actual testing of materials according to specifications comes under the

classification of routine laboratory work, requires no originality or research ability and only laboratory manipulation. It should, therefore, be reduced to a minimum in the ceramic curriculum. The development of a method of testing a product or a material to reveal some particular property is a research problem because it involves original and creative thinking.

Accelerating and Improving Ceramic Instruction. 1. Lectures versus Recitation Courses

While it is true that ceramic instruction is handicapped by the lack of texts, it is also true that ceramic instructors have been teaching long enough to have their lecture notes in shape for mimeographing if not for publication in book form. Instruction by the lecture method, not accompanied by recitation is a slow, cumbersome method conducive to inefficiency and periodic spells of cramming on the part of the student, instead of a steady day-by-day preparation and systematic study. We have found at Seattle that we can cover far more ground and in a more thorough fashion by studying in advance for each lesson from mimeograph copies of the former lecture notes or from selected references in the literature. In this way, we have increased the amount of work covered each year and are ready for the new phases as they appear. Courses are made flexible and those portions, which from time to time decrease in comparative value, are relegated to the side lines for reference reading. This method imposes a greater load on the instructor. It takes more studying, planning and a greater knowledge of the subject to handle a recitation class than a lecture course.

2. Coöperation of University Instructors

In most cases, each instructor is a specialist in a few of the ceramic branches, yet he is trying to cover all of the field, in some portions of which he has had no practical experience. By coöperation and the formation of a working organization, the ceramic instructors of the country could each prepare a set of notes on those subjects in which they have specialized and distribute them to the other members for reproduction and use in class work. Such an association lies in the province of the AMERICAN CERAMIC SOCIETY. So far no attempt has been made to get together. This is due no doubt to the limited number, the personal character of the schools and the lack of appreciation that ceramic education is one of the vital factors in the ceramic industry. The educational committee of the AMERICAN CERAMIC SOCIETY no doubt had such an organization in mind when it started this recent agitation.

3. Teaching Resourcefulness

Since no ceramic curriculum can cover the details of the whole ceramic field in four years, we have to fall back upon the general fundamentals.

Prof. Watts' recent summary of the ceramic courses shows that this is the position of the schools today. The ceramic instructor has very little to do with the teaching of the engineering, chemical, physical or mathematical fundamentals except by a revision during the third and fourth years of those phases dealing with ceramics. But, if only the fundamentals can be covered in four years, the instructor should place the student in a position to be able to pick up the special details as he needs them in the industry. He should be familiar with reference reading, abstracting, and should know where to find data and how to separate the kernels from the shells.

Resourcefulness can be greatly accelerated in the laboratory courses. The laboratory problems should be standardized only in regard to the subjects covered and the methods of attack. Laboratory work should be made research work wherever possible. More stress should be laid upon methods of gathering data, assembling, outlining and planning work rather than covering a larger number of standardized laboratory studies which have been planned in detail by the instructor to save time for the student and work for himself. As the classes have grown in size, it has been natural to change from the individual contact method to the group contact and the individual student has suffered. When he gets into the industry he has no source of information save that which he can dig up for himself. No one lays out the work for him and such independence is disturbing to any immature graduate unless he has been taught self-reliance, resourcefulness and ingenuity. The question of introducing more work on ceramic products and methods of testing finished wares is a small one compared to that of teaching each student methods of forging his individual key to open doors into new problems. The university should not be considered a filling station but a training station.

4. Encouragement of Exchange Ideas with the Industry

The ceramic instructor can get better coöperation from his students in their thesis work if they know that their problem is one which has an immediate bearing on some commercial problem. The instructor should be in active touch with all phases of the industry, know the plants, the technical and executive managers in order to keep the school work up-to-the-minute in all ways. We keep on file a list of thesis subjects which have come from the factories. Contact, familiarity and friendship go a long way toward better coöperation and understanding, and ward off criticisms with their unfavorable advertisement.

5. Elective Courses

Enough elective courses (at least 8%) should be provided to enable the student to pick up a few fundamentals in business administration, economics, factory management, psychology, etc., so that he will be able to appreciate the financial, sales, cost and administrative side of our

industries and have enough of an introduction to this work to enable him to continue such studies after he leaves school. If more graduates were given the idea that while their college days are over, their studying days are to be continued indefinitely, we would have less trouble with them in the industry. They should be taught habits of study. Electives in art and architecture for training in "form, color and design" do not belong directly to an engineering education, although if a man knows that he will be employed by a manufacturer in which these subjects are essential, it would be well for him to choose some of them with his electives. Therein lies the difficulty. He can make a far better preparation for his future job if he knows what that job will be, but he cannot be expected to cover the whole ceramic field. We believe that the whole difficulty of the present situation lies in the lack of knowledge, understanding and appreciation of both sides of the question.

PAPERS AND DISCUSSIONS

A DISCUSSION ON "THE COMMERCIAL DECORATION OF GLASSWARE"[1]

By Theodore Lenchner

ABSTRACT

A discussion of art in connection with glassware as existing among the glass manufacturers of America, and a comparison with European manufacturers. The probable causes of this situation are brought out and a suggestion for the remedy is given.

This is a discussion of the commercial decoration of glass as practiced among American manufacturers of today. At the outset let me say that we, in the American Ceramic Society, are too often apt to think of art in terms of clay, when, as a matter of fact, glass can lend itself to artistic shape and decoration just as much as clay.

One of the largest manufacturers and decorators of glassware told me that one of the best selling articles they ever produced was a pair of candlesticks, in shape and design that of a Corinthian column, yet decorated with an Egyptian motif.

There are three fundamentals that the manufacturer must consider in creating a piece of decorative glass. First, the ease of applying the decoration, that is, the decoration must be simple enough that girls or men, without any artistic talent, can be easily taught to apply same. Second, the ware must be decorated in such manner as to require the least amount of operation or handling. Third, the decoration must appeal to the eye of the average buying public, and here is where the fault lies as far as real artistic production is concerned.

The standards of the average buying public, insofar as art in glassware is concerned, are very low. You, therefore, can conceive that this branch of ceramics needs considerable elevation also.

American glass manufacturers do not employ art directors as far as I know, but they do employ men capable of instructing others. There is one exception and this firm turns out a grade of decorated art glass which is beyond the reach of all the others and I dare say they conduct a more profitable business. Most glass manufacturers with whom I am acquainted, care nothing about creating a style of their own. They want something that will appeal to the average buying public, and that appeal at the present time seems to be a riot of applied color which clashes vehemently with what would be considered artistic color or treatment.

These pieces shown are not the production of American manufacturers. They show the difference between our commercial decorated ware and that which is produced in foreign countries. These pieces represent care-

[1] Presented at the Annual Meeting, American Ceramic Society, Columbus, Ohio, Feb. 1925. (Art Division.)

ful thought as to design, shape and application of decoration. Of course, this takes much more time to make, the cost of which the buying public would not pay.

Relief decoration, rarely produced in this country, has been built up by repeated application of enamel and fired. This is done entirely by hand and shows great skill.

MISS SHEERER: Are these fired more than once?

MR. LENCHNER: All are fired but once with the exception of relief enamel.

MISS SHEERER: In the case of that amber colored one, is that color on top of the glass or is it in the glass?

MR. LENCHNER: This is a yellow luster sprayed upon the glass, allowed to dry and a design in another luster rubber-stamped thereon.

MRS. WESTFELDT: Can you put two or three colors on at the same time?

MR. LENCHNER: Yes.

MISS SHEERER: The luster could be taken off without injuring the glass? Would it wear off easily?

MR. LENCHNER: Yes.

MR. ST. JOHN: Are the petals made and then set on?

MR. LENCHNER: No, the petals are simply painted with enamel and built up in layers and fired perhaps three or four times.

MR. ST. JOHN: I understand that they are making the flowers, then putting them on paper and firing the flowers first. The base enamel is then put under them thus overcoming the trouble of raised enamel boiling up or flowing out from underneath.

MR. LENCHNER: This is something that is giving the glass decorators some thought, inasmuch as they would like very much to imitate Wedgewood on glass. The relief enamel has a tendency to melt out of shape and this decoration (referring to glass with lily-of-the-valley clusters) is the best I have ever seen. Just exactly how this was done I cannot tell. Probably some of our Bohemian decorators could answer that question.

I might add that in this country there are few American decorators. The foreigners are very skilled in this work and they head most of our decorating shops. I am glad to state that some of our manufacturers have given this matter some consideration and have placed their own trained men at the head of their decorating shops. These men, while not trained in an art school, are sufficiently versed in the processes of treating glass and the application of vitrifiable colors that, for the class of decoration turned out in this country, their talents are sufficient. In many instances these decorators show originality and in lots of cases they are more suited to their work than the foreign decorators. This is probably due to the fact that the foreigner is not so well trained along the lines of quantity production.

MISS MARY L. YANCEY: Do they have any designers educated in this country, or would there be any chance for a young man or woman trained in art work design, to be employed in a factory of that kind?

MR. LENCHNER: I believe American manufacturers would welcome young men and women trained in art work design and would give them the opportunity to apply this design, after a course of apprenticeship in the various processes used in decorating.

MISS YANCEY: How should one go about learning the trade?

MR. LENCHNER: It is simply a question of apprenticeship under one who knows the various processes used in decorating glassware.

MISS YANCEY: That would have to be done in the factory?

MR. LENCHNER: Yes, as there are, unfortunately, no art schools or studios in this country, at least I have not heard of any. However, if you are willing to learn, I believe some of the manufacturers would be glad to give you the necessary training, provided you can do the designing.

PROF. COX: I would like to know if you could tell me how a little thing I saw in the Salon in Paris was made. It was glass, but there were partitions. It was a little bowl, and looked to me as though the glass had been cast in little pieces and then joined. The design was some little flowers, I do not recall just what. It was a studio piece of work. The quality of the glass was extremely fine. It was a very carefully compounded glass. It had a limpid quality that was most beautiful and which most glasses do not have.

MR. LENCHNER: In the foreign countries they do a good bit of casing of glass, and I believe that is the thing you are talking about. They will, for instance, gather a piece of crystal glass and superimpose over that a glass of another color. The coefficient of expansion of both glasses will have to be similar. Then they will cut through the superimposed glass, into the crystal glass, and give you these various effects.

PROF. COX: This was an enamel without any metallic backing. I have never been able to lay hands on a description of that process. It would be an ideal process to use in such schools as Miss Sheerer's. The results would be fine.

MR. LENCHNER: Our manufacturers do not very often case their glass. This requires great skill and we do not have the men trained in that art. There are one or two concerns that employ probably one half dozen men, well versed, and they are doing excellent work along this line. However, their art is different. They employ no vitrifiable color or stain, but depend entirely on hand manipulation of the glass which is known as off-hand ware.

PROF. COX: Is it possible to have a satisfactory literature on this kind of work? We have some works at our library at Ames that are not at all satisfactory. They are not sufficiently explicit, they are not technical, they are not written by a technical man, generally, but by an artist who is interested rather in the form, and entirely satisfied from that point of art. But when you want to go about doing a thing, the exact way will have to be stated.

MR. LENCHNER: I have searched through the libraries in the hope of finding some satisfactory literature, but could find it nowhere. There is nothing even satisfactorily described in European literature, for that matter.

PROF. COX: I wonder if you or your friends could be interested in that. First of all, if we are to help the industry we have to have a literature from which to teach. There is a literature in other lines. The brickyard literature has been built up by men willing to contribute from their experience. Are there trade secrets?

MR. LENCHNER: The processes used in decorating are more or less trade secrets. If you are really interested, I will put in writing some of the processes used.

PROF. COX: If you will give that kind of a start, the art schools will do their part. Some one from the Cleveland School of Art asked for help, wanted to know what they could do. This woman from Cleveland said they were out to serve the State of Ohio. If the manufacturers will suggest to them what training to give, they will be glad to give it.

Iowa is not a state for the production of glass, nor is likely to be very soon, although we have glass sand out there. If a person is interested in this sort of thing we have plenty of elective room in the senior year to permit the student to take up what he is interested in. We are building up along that line with the thought that if the industry will coöperate, give us what they have got to build on, we will in turn be glad to do what we can to help them.

MR. LENCHNER: I believe if you will take up that subject with the

glass associations directly you can get an idea as to how they feel about this, and they would probably assist you considerably.

PROF. COX: We want to make it plain that the artist is willing to become practical, to be instructed by the practical man. If we can get a man like you to come into this Division, I think the Division will function much better. These artists will after all be out looking for jobs to make a living and they want to know how to do the jobs.

SAGGERS IN THE EARTHENWARE INDUSTRY AND DISCUSSION

BY A. V. BLEININGER

Introduction

I thought I would start out the discussion by bringing out two points that might be of some interest in connection with saggers used in the semi-vitreous industry, and these points are quite obvious. In the rush of business which has prevailed for some years our plants got into the habit of taking sagger clay immediately from the car and putting it into the soak. After we had a better chance to improve things we insisted that under no circumstances should sagger clay be used direct from the car, but it should be treated in a certain way.

Preparation of the Clay

All we did was to get some sprayers (like lawn sprinklers) and from time to time we would give the clays a slight soaking. We found that it is not good practice to drown the clays, to give them so much water that they will become slimy on the outside, but to give them a smaller amount of water from time to time until the larger lumps begin to crack and fall to pieces. After the clay has reached that condition it will take more water, but the point is that under no circumstances should clay be used direct from the car without having undergone this treatment.

After this had been done for some time the saggers began to improve. They responded at once, which showed that in the hurry and rush of our previous work we had neglected this very important part of preparation. We all know that clay which is simply taken from the car and then put into the soak pit is in no shape to take water in the proper fashion, because it is not ready to receive it. This preparatory treatment outside should be given to all the sagger clays.

In one of our plants we have a wet pan. We introduced it simply because we thought that we would obtain with it a more thorough and satisfactory preparation of our sagger clays, but we have been quite disappointed with it. We have not obtained the results that we expected.

Even with the use of the wet pan we have found that the clay should be treated in the fashion which I have indicated. Even the wet pan is not sufficient to replace the long-time treatment with water, causing the clay to take up its water slowly and gradually but completely. The intensive treatment in the wet pan for ten minutes is not equal to the long treatment of first the preliminary soaking and then the final soaking, which we get in the old-fashioned process.

Rapid Cooling of Glost Kilns

Another point on which I would like to invite discussion is this, which also has to do with the hurry and rush methods which have prevailed in the pottery industry. This is the cooling of the kilns. Under the schedules which have been prevailing during the past few years the kiln was opened and the saggers were drawn about as fast as it could be done; in other words, very frequently a kiln was finished (a glost kiln I mean) and a hole was torn in the door and cooling started immediately, and in order to help things along if the schedule was slowing up they took a good-sized fan and blew cold air into it. That created conditions which are exceedingly hard on the saggers.

It seems to me this extraordinary fast cooling is one of the prominent factors connected with the high sagger losses. We believe that with slower cooling we reduce these losses considerably.

In discussing sagger clays and saggers we must recognize as one of the greatest factors the resistance of the sagger clays and the sagger mixes to sudden heating and cooling. This is a very important point in connection with the study of saggers.

Effect of Repeated Heating on Thermal Expansion

Furthermore, it has been found in the course of observation that the saggers changed in their behavior in regard to their resistance to sudden heating and cooling. One sagger mix used by us, when saggers made from it were used several times, showed a fair resistance to sudden heating and cooling but the older it got the more sensitive it became and the less the resistance to heating and cooling. I do not know just where but a point was reached not very long in the life history of the sagger when it became exceedingly sensitive and it cut, or broke in two. This increasing sensitiveness to sudden temperature changes is an important point, and we have been led to believe that some results might be obtained by studying these clays with reference to their thermal coefficient of expansion and the change of the latter upon heating a number of times.

We imagine this might be true: That a sagger when first fired has one kind of thermal expansion but when fired a second time and oftener this property changes very markedly. We should know how the sagger changes in its coefficient of expansion. We should know the change in expansion with the temperature, and with time, *i. e.*, repeated firing.

I have taken the liberty of trying to start a discussion, first, with reference to the preparation of the clays, by making use of the gentle soaking preliminary to the final soaking in the usual method of preparation. Second, the sensitiveness of the saggers to sudden heating and cooling; whether or not it might be possible to obtain better results by slower cooling. Finally, it would seem to be desirable to know something about the relation between the coefficient of thermal expansion, temperature and time.

Testing Sagger Clays

We have tested sagger clays forward and backward by all of the older, well-known methods, and it seems to me that we do not know any more about sagger clays than we did before. We know certain things. We know whether the clay is weak or strong. We know how it will hold up in the green state, whether it is refractory enough, etc. Those points we, of course, have established, but as to what life of the sagger may be expected, we cannot predicate, and we must look for some more definite criteria than we have now.

Some clays give poor results, although they may conform to the required drying shrinkage, fire shrinkage, porosity, etc., yet owing to some kink in the structure they are absolutely no good. I do not know the cause. That is the reason why I would like to get a discussion started as to methods by means of which we can get at the real facts in the case and get at some knowledge as to how the sagger clays will behave in the kilns and whether we could not by some such means as the thermal expansion study get at the real happenings within the sagger body.

Sagger Investigation

So far, our progress in the sagger studies has not been very illuminating. But we have some better perspective for further work. Some years ago the proposition was made that an investigation be started on saggers and sagger clays. I have been accused of not being enthusiastic about it at that time, and I must say that I am glad that we did not undertake the work then. Our viewpoint at that time was too brash, too self-confident, and we were too sure about getting something. As a matter of fact, I think the result would have been that we should have spent $25,000 and not had anything to show for it. I do believe that we have a better realization today of what we must look for; namely, not the exterior changes in the clay but those taking place in the interior, those molecular changes, which make good and bad saggers.

Discussion

R. A. Heindl: I happen to be the member of the Bureau of Standards staff in charge of the sagger clay investigation and agree with Mr. Bleininger that as far as ordinarily determined physical properties are concerned

I also have found the correlation of results obtained very unsatisfactory. Mr. Bleininger, how long does this presoaking or sprinkling treatment cover?

A. V. BLEININGER: I would like it to cover as long a period of time as possible. It should be at least three weeks to a month. That depends on how fast the clay comes in, but if possible we would like to have it undergo this treatment for a month at least, during the summer and fall. In some plants we cannot do it at all in winter.

C. L. SAYRE: Would the preliminary weathering of the clay at the mine take care of the preliminary soaking?

A. V. BLEININGER: Yes, it would, but most sagger clays are not treated this way at all. They still have the mine moisture in them and they will not take water except very slowly.

T. B. ANDERSON: I entered the pottery business through a sagger shop, back in the early days. A large pottery firm started to make vitreous china. They found that they had made a serious mistake in underestimating the size of the sagger shop to take care of vitreous ware, therefore it was necessary for them to build an auxiliary plant which is still in existence as the Potters Supply Company. We put these sagger clays in bins in which there was no preliminary aging or sprinkling. We made saggers out of them for a china plant.

We had ample drying room and ample firing space, so we gave them lots of time. Those saggers were very satisfactory in the firing of chinaware and were used in the bisque kilns at the china works as long as they were making china. The size of the sagger shop and the methods of drying saggers are points I wish to emphasize. A good deal of the cause of structural weakness in saggers is because of the limited space and the method by which saggers are dried. All cracks in the saggers are usually vertical cracks of various degrees from the top edge to the bottom. Some appear very soon after the sagger is made, and some appear when they come out of the bisque kiln.

We all know that in the electric porcelain business there are large pieces that must go through humidifying. There are also millions of bricks made in this country that would not be gotten ready for the kilns unless mechanical humidifying driers had been constructed which heat the brick to an even temperature before the moisture is expelled.

In most sagger shops a sagger is dried quite dry almost half way down, and then it is turned over. It is natural that there is a structural strain in that clay before it ever gets into the kiln. That has always been the case, but more the case now especially in whiteware because very few of us (we have enlarged our capacity, increased the turnover of our kilns) have increased the capacity of our sagger shop. It is very often stuck away in some corner where it originally started.

So it seems to me that if we are going to have better saggers we shall

have to pay more attention to them. If these saggers were sold in the open market there is no question but what we would pay a lot more attention to their manufacture in trying methods of making them and firing them and there would not be such a loss. The method of drying them is one of the reasons for our big loss of saggers. If any one is using a humidifier or a drier of that kind I would certainly like to know their experience on this thing.

T. H. SANT: Mr. Sayre made a very important point when he talked about the clay producer weathering the clay before he shipped it. He is in position to do that usually much better and much more easily than the potter, because, except in such large institutions as the one Mr. Bleininger is connected with, there is no room to do that and usually they do not have the time to do it. If they run short of sagger clay, they get a car in and want to use it right away. The clay producer, if the manufacturer insists, will have it weathered. The manufacturer on his part should meet him part way and pay a little more for it. Naturally the increased cost has to be taken care of, but results can be obtained that way. I am thinking particularly now of one clay which is weathered for 12 months and the results obtained by that weathering are remarkable.

F. S. CRUMLEY: Some one raised a question about the saggers cracking from the top down. Is it his idea to retard the drying of the sagger in order to have more uniform bottoms? How would you do that?

T. H. SANT: Inasmuch as the bottom is protected by a board, the top should be covered to prevent a circulation of air on the inside and around the sides. That is done in some of the plants where they have large pieces. The ware is given quite a while to dry; they usually wrap it and put barrels over it. I am not as familiar with the latest processes. It has a tendency to heat the ware to an even temperature before the moisture is expelled.

F. S. CRUMLEY: It has been our experience that in retarding the drying of the sides of the sagger you eliminate those cracks.

A MEMBER: What should the original sagger firing temperature be in relation to the firing temperature of the product? I know of a number of firms that fire the product and saggers around cones 2 and 3. If they brought the ware to cone 8, I would want the original sagger firing to reach between 9, 10 or 11, or at least a couple of cones higher. That would have a bearing on the life of the sagger.

A. V. BLEININGER: Theoretically it would seem that we should fire the saggers to a temperature as high as that being used, or higher, but practically we do no such thing. We fire to cone 8 regularly but the saggers get the benefit of only cone 6. I do not know how high they should be fired to get the best results, but theoretically they should be fired as high or higher than the temperature to which they are being subjected in the regular firing.

H. GOODWIN: The question of saggers was discussed at our St. Louis meeting in 1922, at which time the statement was made by the superintendent of a whiteware plant that they did not fire their saggers at a very high temperature the first fire and supplemented it by saying that they had gotten good results. With this statement I took issue remarking that it was contrary to my experience, having always found it the other way about. Take, for instance, a sagger used in glost kiln having a high absorption will take up a greater volume of glaze wash, thereby affecting the contraction of the sagger as well as its life because the body would be denser and rapid cooling would affect the life. Such saggers vary in size when wadded; the wads would not remain in place due to the lack of weight, thereby admitting sulphur from the coal and air with the result that much ware is bad, especially so in all saggers containing flat pieces.

In a bisque sagger fired at a lower temperature the first time, it has not the strength to carry the load of filled saggers above it, with the result that the bottom pushes up, bulges out and bungs fall over like ten pins. The only way to get a good sagger is to fire the first time so that it will stand the strain.

The making of our saggers today in comparison with those made a few years ago is likewise a factor, therefore, not being made to the same degree of perfection we cannot expect them to give us the same life which they did years ago.

Some made reference to the $25,000 which was injected into the proceedings at St. Louis. I think it would be a good thing, yet I do not think the U. S. Potters Association should do it alone, because the subject is so far-reaching. Other industries in different parts of the country should be taken into consideration and should assist financially and otherwise. I would like to see some unified action taken whereby the manufacturers can use one test plant. I do not believe any one alone will solve this matter. We know the Bureau of Standards has been working on it with various clays.

W. L. SAMPLE: In regard to remarks on firing, the first firing or the green state should be a little higher than the temperature to which it is fired later on. I know I have had good results doing that. I can remember some eight or ten years ago a friend of mine in the pottery business told me how he was getting results with his saggers. He had a spare kiln and his men carried the green saggers into this kiln until it was full and then fired it. He fired this kiln two cones higher than he expected to go when using them. He told me further, "I dare not tell anybody, any manufacturer, how low my sagger cost is because they would think it was not true."

A MEMBER: How long can you use your grog?

A. V. BLEININGER: I do not know. That is a difficult question to answer. It is a question of whether bisque or glost grog is used. Glost

sagger grog becomes bad in a short time. Frequently, when you take a grain of glost grog and examine it, you see that it contains hundreds of small drops of glaze. These are minute, but still they are there, and they are effective. Therefore, I really could not answer this question as to how long the grog can be used, because I do not know. Broken saggers of a superior refractory quality could be used for quite a long time, because they would not be suffering in their refractoriness in use. But the lower the refractory quality of the sagger as a whole, the shorter must necessarily be the life of the grog. Of course, as sagger losses have been, we did not worry about them because we are replacing the clay so often and in such large quantities that it remains freshened up in very good shape.

A. A. WELLS: The potter wants a sagger having a long life. Sometimes that is not as unadulterated an advantage as it might seem. We have found saggers that after repeated firing were still good, sound saggers; that is, good enough to go into the kiln, but they have reduced so much that they are actually a cost to the plant.

Here in the past year we noticed a peculiar thing in one of our plants. They had a higher sagger cost than any other. Nevertheless, the lower percentage of kiln dirt that we got more than balanced the added cost. They were apparently tight saggers, so tight they cut short life, but no kiln dirt. I think that is a point that should be considered in merely long life saggers.

T. A. SHEGOG: I should like to ask Mr. Bleininger about the weathering of clays. I remember many years ago at a meeting of the English Ceramic Society we discussed that question at great length. There was a very general agreement that the shorter life the sagger had at that time compared with what it had had some years before and although made of precisely the same clays was due to this lack of weathering.

At that time the clay was mined one day and made into saggers the next. The trouble became so acute that many plants experienced extreme difficulty in keeping up their stock of saggers. I approve of the wet pan treatment for sagger clays. Did Mr. Bleininger mean that the sagger mix does not derive a benefit from the wet pan treatment? I do not for a moment suggest that the wet pan treatment is a substitute for the weathering, but as a mixing agent I think the wet pan has no equal.

In many of the whiteware potteries, the sagger is turned over as soon as it becomes dry enough. It is turned over on the board and dried upside down. The main idea is to prevent the dishing which we sometimes see in saggers after they have been fired a few times. The inversion of the sagger in drying it in that position curves the bottom and makes it less liable to dish in subsequent firing in the kilns.

In regard to quick cooling, a case came under my notice a couple of months ago where owing to one of a set of glost kilns being continually

under repair they were cut down in their glost capacity from four kilns to three, and out of those three kilns they got nine kilns of ware. That involved cooling of the most drastic order. The fan was used as soon as the door was broken down. I made the suggestion there, but to my surprise it was not acted upon. In that town they have a local fire department which does not get much work and I thought they could utilize this department to turn their hose into the kilns to quicken it in that way so as to become cool much sooner.

A. V. Bleininger: The point which I made in regard to the use of wet pan was this, that in the plant using it, the sagger cost per kiln or per thousand cubic feet of glost kiln space is somewhat higher than it is in the other plants using the old process.

I think Mr. Shegog is correct when he says that the wet pan is an ideal mixing machine, but it does not do away with the necessity of the preliminary sprinkling treatment. I do not mean by this an ordinary wetting, but a systematic sprinkling of the clay from time to time. In using the wet pan the men got the idea that it offered such a thorough preparation that the preliminary wettings were not so necessary.

C. C. Engle: I have had a good deal of work along clay technology from the agricultural standpoint. I believe ceramists will have to turn more to the microscope just as our colleagues, the soil people, have had to do.

I am sorry that I do not have some of their figures with me. Some of you are familiar with some of the work that has been done but if you were to know the figures which give the area, for instance, of an ounce of clay particles, the area that they cover, it would amaze you. I think that is tied up with the weathering.

Speaking of weathering, my understanding of your point of view is that you get a thorough saturation. I am inclined to think that the clay miners cannot do that for you, unless we put in concrete bins or something of that sort, because if we pile it out as we do at our mines—not as much as we would like although we pile out a great deal of clay to be weathered—in the summer that clay would be extremely dry sometimes. It is practically bone dry when we ship it. It may have benefited by that weathering but to accomplish your purpose it seems as though you would have to begin right at the same point as though the clay were moist. I do not see how we can accomplish that for you.

I think that you want to turn more and more to the microscope.

K. M. Smith: Dr. Mellor of England, while visiting our plant suggested that we add tannic acid to the sagger mix. He makes tannic acid by soaking straw in water and using that water. He also suggested that we soak the grog, keep it in the bin covered with water and get it thoroughly soaked, and when we are putting up the sagger, shovel that

wet grog out into the sagger soak. He says it causes a better bond between the clay and the grog.

C. F. Geiger: Saggers are about the poorest quality of ceramic product made in this country. I think there are two things wrong with saggers. In the first place, the shape is very bad. We can take a hand-made ring that would correspond to the outside ring of a sagger and make it quite accurately and likewise make a bottom from a solid piece of clay. If we put that through the regular drying and firing procedure we shall find that in most cases the rings will shrink more than the solid body. In one case we had a total shrinkage of 10%. In this case, the solid bottom was about $6^1/_2$%. Then we try to stick those two bodies together and the result is, of course, that we set up some very severe strains, and those, of course, shorten the life of the sagger. I think that undoubtedly is one difficulty.

Another is in the formation of the sagger. Most of us are using sagger presses and we throw a wad of clay on the bottom of the box and the plunger comes down and spreads the clay. It is supposed to force it up in around but we certainly do not get uniform pressure or density throughout the mix. We spread it and do not put it under compression as we do when we form fire brick.

C. D. Fraunfelter: I have had the same point in mind, except that I believe in employing mechanical pressure on the outside bottom of a sagger made upside down, the platen of the press covering the entire bottom surface. I have always kept a Patterson Steam Press for this purpose, believing that we had a more uniform density of side walls, corners and bottom than by any other method of manufacturing.

C. F. Geiger: My suggestion on the first point was that we might try separate slabs for the bottom and rings for the side. Some of us can do that, although we think we cannot. We have let the man in the shop tell us we cannot do it. Use a heavier bottom slab and loose ring.

R. V. Miller: We are using a wet pan process. We do not soak the clay as Mr. Bleininger has explained; but pass it through the wet pan and age it for two days or more when possible. When this clay is not aged it does not work as well for the sagger maker. They can always notice that difference. As to the life of the saggers, I cannot give you any figures as we changed our mix when we installed the wet pan.

R. W. Hemphill: Somebody raised the point about the use of humidity driers for saggers. We tried it out and it works all right. We do not do it right along but I know the idea is good. I think the reason saggers stand up when fired at higher temperatures is the mere fact that they are more refractory. They cannot help but stand up better.

K. M. Smith: We have found that the life of our rings is not as long as the life of the saggers. I would like to have that accounted for.

F. H. RIDDLE: Is that because they lack the reinforcement the bottom would give?

K. M. SMITH: They get practically the same as the sides do.

F. H. RIDDLE: We tried two or three times making the walls of a different mixture. Of course, where there are different shrinkages the wall will be torn off. That is one thing to be careful about.

DISCUSSION ON "DUNTING AND SHIVERING OF PACIFIC COAST CLAYS"

BY RUFUS B. KEELER

It seems that everyone of us at one time or another has had to deal with the question of dunting, and it is rather difficult to explain the real reasons for this phenomena.

I have in mind a certain terra cotta cornice, which was made many years ago, and shipped to the state of Utah. This job developed dunting shortly after it was in place, and after two years' time I inspected it and found that fragments of the cornice were continually breaking off and dropping onto the ground. It was apparent that dunting had been primarily to blame, and that the freezing and thawing action of the weather had completed the damage. I inspected some of the same pieces, retained as extras on this particular job, and which had remained on the Pacific Coast. These pieces showed very fine dunting cracks, but bore no other evidence of separation, such as did the material on the job.

Since that time dunting and shivering seem to have occurred periodically at various times in various factories; in many cases shivering the glaze from the surface of the ware on all the rounded moldings.

In the manufacture of domestic stoneware on the Pacific Coast this same shivering has been in evidence even in round jars. The shivering cracks occurred either as long straight vertical cracks, or else spiral cracks, starting from the bottom of the jar and running to the top.

In the manufacture of chemical stoneware I have seen perfectly good ware come from the kilns, and after exposure overnight, or perhaps for a few days, the same dunting appeared as in the domestic stoneware bodies. The cracks would manifest themselves either by sound or might be seen by bathing the surface of the body with water.

Sanitary ware made from imported china and ball clay together with customary flint and feldspar additions has also dunted, the same being delayed sometimes for many days. In fact, it would not be unusual to hear the cracking sound at night in the warehouse from all sections of the stock pile. We often find that our so-called safe and perfect bodies periodically develop spells of dunting.

The first place we look for the correction of this difficulty is in the cooling of our kilns, believing that the quick cooling would induce the cracking of the ware. It is usually found, however, that the ware cracks just as badly, if not worse, when the kilns are completely mudded up after firing, and allowed to cool very slowly.

In the second place, we usually look for an excess of free silica in the body, believing that a formation of tridymite is responsible during the cooling period. This belief, however, is offset by the fact that the addition of ordinary clean quartz sand to such a body often minimizes the dunting, whereas, theoretically speaking, it should immediately cause increased dunting.

Lastly we look to our body, not as to the analysis of a single sample, but as to the general character of a carload of clay, making samples of the car in general. Stiff mud pressed trials have shown that very few of the average fire clays on the Pacific Coast really fire hard and compact at cone 8 or 9 and remain so for any length of time. In fact, pieces which have a fairly good ring after coming from the kiln seem to lose this tightness and become chalky after several days' exposure to the air, and very often small dunting cracks are seen upon close examination.

It is apparent, therefore, that a great deal of knowledge is yet to be gained regarding the dunting of various clays which we use commercially on the Pacific Coast. I do not have reference to the very small stiff mud pieces that are usually made from these clays, but to the larger and flatter sections which range from a foot square upward, and are usually made in thickness varying from $^3/_4''$ to $1^1/_2''$.

In conclusion I will say that the clays themselves seem to be largely responsible for their actions after firing and it has been my experience that very few clays, or very few mixtures of clays may be relied upon. It is my sincere hope that some of our members will contribute their experiences to this discussion.

California Clay Products Co.
Southgate, Calif.

DISCUSSION, ON "BALLING IN CAST WARE"[1]

E. H. Fritz: Do you have any trouble in filling the mold this way and casting it and getting this section right here?

W. K. McAfee: That section could not appear in a finished part of the piece, of course; that is, there would have to be a little finishing that would probably show. If that was on the front of the piece of sanitary ware where it is apparent something else would have to be done. Fortu-

[1] W. K. McAfee, "Balling in Cast Ware," *Jour. Amer. Ceram. Soc.*, **8** [7], 430–1 (1925).

nately it comes on the bottom of the tank where it is not easily seen. It does show slightly.

R. W. Hemphill: We tried to cast a piece about one and one-half inches thick. That is pretty thick for our slip. The piece always split up on the inside and cracked. We could not do it at all. I know that the body was not right to cast that heavy, but at the same time the same laws ought to apply to it.

C. C. Treischel: What effect will the condition of the slip have on balling?

G. T. Morse: In some cases where the slip is a little thick, in casting heavy pieces the outside has a skin on it. It will not cast in the center, especially if there is high balling.

C. C. Treischel: Will that cause balling or hollow centers?

G. T. Morse: It will not cast in the center at all if it is left in the mold too long. If it should be cast up in 12 or 14 hours and it is left double that time hoping it will cast, it will be worse.

G. M. Martin: Anybody who has cast has had that experience. We pour the tanks opposite from the way that was poured (that is, from the top of the tank). We have a ventilating funnel in one corner and pour from the other. As long as we can keep the slip in condition and keep the flow steady, we have no trouble with balling, but if the slip runs heavy, as it does occasionally when we get off in the clays, we usually have trouble with balling.

A. Foltz: If fifteen casters work on a certain floor, there will be no one of those fellows who will have at least 75% more balls than anyone else. Some of them never have any. And the other fellows may have one out of one hundred. You will have some fellow who will have twenty in a week. There must be a great difference in how the work is done, because if the slip is prone to "ball," it could not be confined to any one or two men in the shop.

H. Goodwin: On that point, we had two men making the same work, using the same molds and the same slip. One man did not get a single piece cracked the whole week and the other got 18 pieces in one day. That shows the difference between the work of two men.

W. L. Sample: To answer to Mr. Foltz's question: Balling, as has been shown, is the direct result of congestion, in a narrow part of the mold, shutting off the supply of slip to a wider section which has not cast solid, and which cannot be drained. The congestion in the narrow part is caused by the section casting solid. A careful workman will see that the mold at the narrow section is sufficiently wet that it will not cast quickly, thus allowing free passage of the slip to the wider section till it is cast solid.

W. J. J. Bowman: If the slip is working right and only balling in

certain pieces it is due to the method of feeding the slip to the piece. If it is due to the body, then the body is shutting off and not feeding long enough. The body change, to stop balling, is to give it a longer feed.

C. C. TREISCHEL: Would there be a change in the body?

W. J. J. BOWMAN: Yes, change the body if the slip stops feeding too early.

C. C. TREISCHEL: In order that this will go down into the records completely I am going to sum up the general impression of this discussion. In the first place, it would seem as though the condition of the slip has something to do with balling; second, that mechanical difficulties in the design of the mold will cause balling; third, that balling can be sometimes attributed to slackness possibly on the part of the workmen; and fourth, to a condition of body structure. I differentiate body structure from the condition of slip because of Mr. Bowman's remarks.

DISCUSSION ON "QUANTITATIVE DETERMINATIONS OF THE DEVELOPMENT OF MULLITE IN FIRED CLAYS BY AN X-RAY METHOD"[1]

F. H. RIDDLE: The different amounts of mullite developed in clays makes me wonder whether this is not the reason that some of our clays have given better bodies than others. Shall we not discover that this is one of the reasons?

R. A. HEINDL: Did you find that fluxes have any effect on the formation of mullite?

L. NAVIAS: The temperature of cone 10 was just high enough to cause vitrification of the feldspar and there was not much contact reaction between the larger grains of clay and the feldspar. I doubt if there was very much influence from that point.

We find in some of the porcelains, for instance, that the mullite development will consist of crystals contained in a clay particle and not in contact. For instance, we will get aggregates of mullite grouped in various forms depending upon the nature of the clay particle and quite often a quartz particle may lay on one side of it and possibly some feldspar on the other, but the effect of these particles at that temperature is hardly sufficient to affect the crystallization in the clay.

K. M. SMITH: According to the chart, is it the clay that is relatively high in alumina that develops mullite most extensively? Would you recommend using bauxite clay or introducing bauxite clay into a body to increase this mullite crystallization and increase the strength of the body?

L. NAVIAS: Your question brings up a number of considerations which

[1] Louis Navias, *Jour. Amer. Ceram. Soc.*, **8** [5], 296 (1925).

we touch on but cannot answer directly. I doubt whether the addition of an aluminous body as such and fired to low temperatures will give us anything more than inclusion of the bauxite or alumina. It would be a matter of filling up space in the body. Now the temperatures which we have to reach in order to get fusion at the surface and intimate contact with resulting crystallization I feel are higher than we are usually accustomed to. However, the subject of aluminous clays certainly ought to be studied from this viewpoint and also from the theoretical viewpoint to determine the correlation.

W. L. SAMPLE: Is there any significance in the fact that the higher silica content in the clay the less mullite is developed? Has this any detrimental effect toward the development of mullite?

L. NAVIAS: So far as I can determine from the calculated values of the maximum quantity of mullite to be obtained we actually obtained just that quantity on each clay at the temperature at which we worked; further that the presence of silica merely acted as a diluent in the body. Naturally we cannot expect any more mullite than is allowed by the ratio of alumina present. The presence of a great excess of silica, colloidal silica, finely divided silica, and also the addition of flint in the body would have the effect of increasing the viscosity of the body at that temperature, and as it was increased, the development of the mullite would at least be arrested to the extent that the crystals would be smaller and possibly have difficulty in asserting themselves in the body.

R. A. HORNING: Was there any feldspar in the mixture?

L. NAVIAS: Feldspar was used as a matrix for the second series. The first series of films showed the clay alone, the fired clay against the mullite, but their density was so great that we were not able to make any comparisons and for that reason we had to dilute the clay in order to make the comparisons.

R. A. HORNING: Did that alumina in the analysis include the alumina in the feldspar too?

L. NAVIAS: No, the figures shown were the analyses of the clays.

J. W. GREIG: In reference to the standards used to compare with the fired clays and feldspars, how were those standards actually determined? How did you happen to know the percentage of mullite in the standards?

L. NAVIAS: The standards were made by taking definite proportions by weight of the mullite and feldspar, mixing thoroughly and firing in the form of cones. These were ground and later examined under the microscope. From that work and from previous work we know that the mullite is not appreciably dissolved. So far as we could determine there was as much mullite as we had put in.

J. W. GREIG: How long must you have the temperature to bring about the fusion of the feldspar?

L. NAVIAS: The fusion of the feldspar takes place at about cone 10.

J. W. GREIG: How long a time is it held there?

L. NAVIAS: It was fired in the regular periodic kiln. The entire firing takes about three days. The maximum temperature is held only for a few hours.

J. W. GREIG: About how many hours would the temperature above the fusion of the feldspar occur?

L. NAVIAS: Not more than four or five hours.

A NEW ELECTRICAL RECORDER[1]

BY THOMAS R. HARRISON[2]

ABSTRACT

The construction and operation of a new electrical recorder is described.

During the past five years the Brown Instrument Company of Philadelphia, Pa., has developed a recording and automatic signalling and controlling instrument of the deflecting D'Arsonval galvanometer type for use with thermocouples, radiation pyrometers, resistance thermometers, thermal conductivity gas analysis apparatus and various other devices mentioned later. When used with gas analysis apparatus the ammeter, adjusting rheostat and slide wire for zero adjustment are mounted inside of the recorder case.

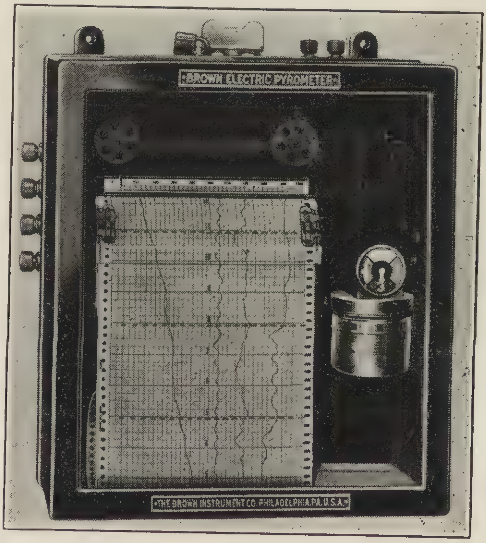


FIG. 1.—New Brown Recording Pyrometer.

Figure 1 shows the external view of the instrument, the case of which is 15 inches high, 14 inches wide, and 9 inches deep. The chart is 7 inches wide and when traveling at the standard rate of one inch per hour, the height of the instrument permits the record for the past 9 hours to be visible. Various other chart speeds are obtainable ranging from $^1/_4$ inch to 6 inches per hour; interchanging 2 gears gives a paper speed of 4 inches per hour.

The instrument makes either a single chart or by use of an automatic

[1] Recd. Aug., 1925.

[2] Director of Research, Brown Instrument Co., Philadelphia, Pa.

switch it makes records from two, three, four or six thermocouples, distinguished by the different colors and color combinations in which the records are printed. A duplex instrument, which has two galvanometers, and two charts printed on one strip of paper occupies a somewhat wider case. By using a duplex instrument with selective switches a 12-point recorder may be obtained.

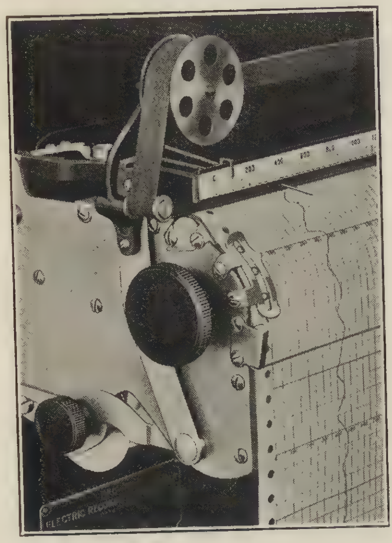


FIG. 2.—Marking ribbon moved back to make record visible.

The chart passes over a rectilinear knife-edge which is at right angles to the direction of travel of the paper and directly above the paper feed roll. A carbon or inked ribbon is stretched across the paper directly above this knife edge. The galvanometer pointer swings above the ribbon and when the depressor bar drops it strikes the pointer causing a dot on the chart.

With one depression each 30 seconds the dots in each record are close enough together to render an almost continuous line. The marking ribbon of the single and duplex recorder, after each mark on the chart, is moved back disclosing the last impression so that the record is clearly visible immediately after it is produced (Fig. 2).

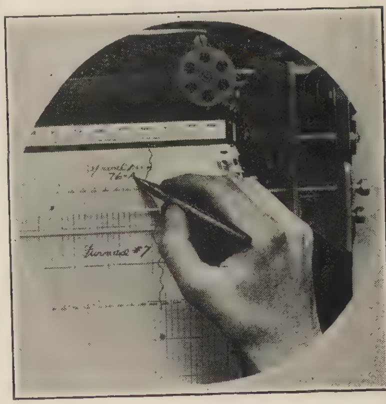


FIG. 3.—Support for writing notes on chart.

An automatic selective switch is used with the multiple recorders which consists of gold contacts mounted on bakelite and immersed in oil. The oil keeps the contacts perfectly clean and in good electrical condition at all times. The switch is provided with a dial marked with the various numbers of the thermocouples and showing the color or color combination corresponding to each as used on the record chart. A hand rotates on the dial showing which thermocouple is connected to the recorder at any instant.

A platen placed directly below the driving roll is convenient for making notes on the record chart with pen or pencil (Fig. 3).

For use with thermocouples the recorder is provided with a bimetallic spring cold junction compensator, and a bimetallic index which indicates the correct "zero" or open circuit reading for the compensated instrument.

Where alternating current is available, the recorder is operated by a 4-watt synchronous clock motor, thus eliminating the winding of clocks, use of governors,

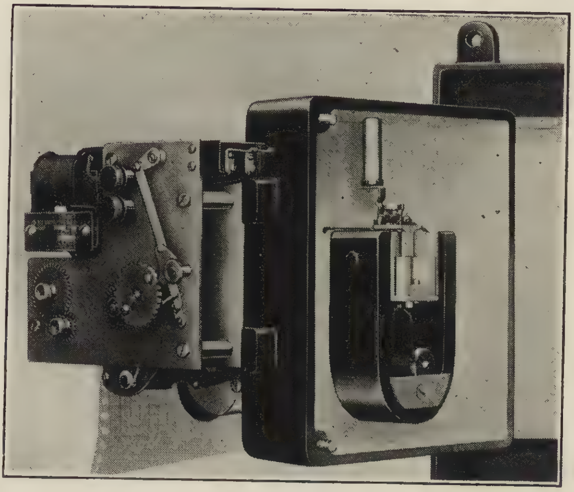


FIG. 4.—Enclosed galvanometer and chart driving mechanism with speed change gears.

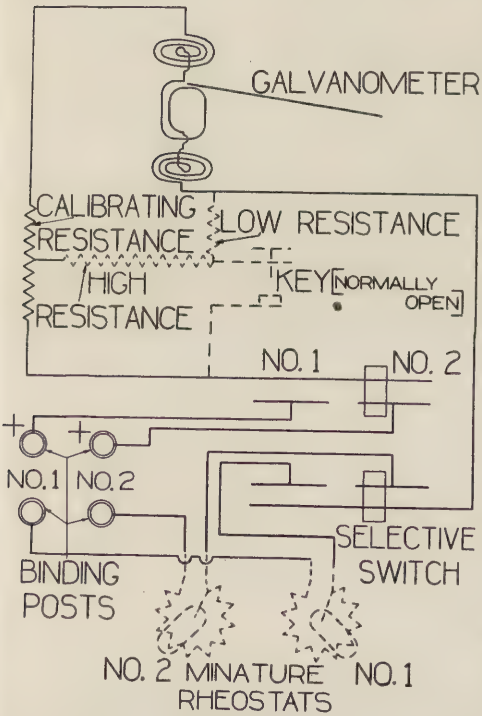


FIG. 5.—Wiring diagram of two-point recording "heatmeter."

etc., for securing accurate time keeping qualities.

These recorders can be supplied equipped with the heatmeter circuit[1] and miniature rheostats equal in number to the switch points on the selective switch. One rheostat is connected in series with each thermocouple circuit. Pressing the push button shows whether each rheostat is properly adjusted to calibrate the instrument for inequalities in circuit resistance caused by various lengths of lead wires, etc. No change in recorder reading when the button is pressed indicates a correct rheostat adjustment, independent of contact resistance, etc. Very infrequent readjustments of the rheostats are usually sufficient but on account of the ease of making

[1] Harrison and Foote, *Jour. A. I. E. E.*, **2**, 20 (1920).

the test it is never necessary to make assumptions as to the correctness of the circuit resistance.

On account of the principle of magnification of errors for making corrections, an adjustment which is apparently good to 5° will actually be good to 1°, and so on in proportion.

The wiring diagram of a 2-point recording heatmeter is shown in Fig. 5, the parts drawn in solid lines being those common to all recorders of this type and the dotted parts being the additional parts involved in the heatmeter circuit.

Where the rheostat contacts may be affected by corrosive gases in the atmosphere they can be supplied in cases suitable for filling with oil which may be mounted within the recorder case or outside on a panel.

A controlling or signalling attachment has been developed for this instrument which is capable of handling larger currents than usual, eliminating the necessity of relays in many cases. The contacts for this attachment are operated by power derived from the driving motor. When the galvanometer needle is depressed the appropriate one of several pivoted arms is swung out of a position of rest. A cam then allows the switch to move forward until stopped by the displaced arm, thus fixing the position of the switch in accordance with the length of the chosen lever. In different positions the switch makes different connections. The pivoted arms are of various lengths to select the different switch positions. Different arms are thrown out by the pointer depressing against different spring extensions spaced adjacently to correspond to the usual high neutral and low positions. Even more pivoted arms and switch contacts can be supplied where desired.

In addition to use as pyrometer recorder, gas analysis recorder, etc., the instrument may be provided with suitable sensitive elements and be used as recording voltmeter, ammeter, tachometer when attached to suitable direct current generator and for a number of special applications.

ACTIVITIES OF THE SOCIETY

NEW MEMBERS RECEIVED FROM AUGUST 15 TO SEPTEMBER 15

PERSONAL

Milton K. Akers, Hobart Mfg. Co., Troy, Ohio. Development Engineer.

Walter Emery, Pottery Teacher, Pottery Laboratory, Stoke-on-Trent, England.

Meyer L. Freed, 26 Cortlandt St., New York City. Chemist for Henry A. Golwynne.

Richard-Ginori, Società Ceramica, Colonnata, Florence, Italy. Insulators and Artistic Porcelain.

Richard-Ginori, Società Ceramica, Casella postale 1261, Milan, Italy. Earthenware and Porcelain.

O. E. Mathiasen, Ceramist, New Jersey Terra Cotta Co., Perth Amboy, N. J.

I. F. Ponomareff, Dean of Chemistry, Director of Sibernian Ceramic Station, Institute of Technology, Tomsk, Siberia.

William C. Snowdon, Technical Assistant, Osram, G. E. C. Glass Works, N. Wembley, Middlesex, England.

Frederick S. Thompson, Glass Technology Department, National Lamp Works of G. E. Co., Nela Park, Cleveland, Ohio.

CORPORATIONS

Booth Brick, New Toronto, Ontario. F. W. Booth.

The U. G. I. Contracting Co., 1401 Arch St., Philadelphia, Pa. D. J. Collins, Vice-President.

Membership Workers' Record

	Personal	Corporation
D. H. Fuller	1	
Charles F. Geiger		1
R. K. Hursh	1	
Percival Marson	1	
Office	6	1
	9	2

PERSONAL NOTES OF MEMBERS

A. L. Donnenwirth has left the Westinghouse High Voltage Insulator Co., Derry, Pa., and is located at Flint, Mich., with the A.-C. Spark Plug Co.

E. M. Durant has moved from Los Angeles, Calif., to 401 Oaklawn, Pasadena, Calif.

James Gould has become affiliated with the Buckeye Porcelain Enameling Co. Cincinnati, Ohio. Mr. Gould formerly was Superintendent of the Scranton Enameling Co.

T. A. Klinefelter of Gladding, McBean & Co., has moved from Lincoln, Calif., to 351 W. Wilson Ave., Glendale, Calif.

Erwin F. Lowry has resigned as Research Physicist for the Armstrong Cork Co., Lancaster, Pa., and is associated with the Westinghouse Research Laboratory, East Pittsburgh, Pa.

Emerson P. Poste has accepted a position as superintendent of enamels with the Chattanooga Stamping and Enameling Company and assumed his new duties with that Company on September 15. Mr. Poste has served as director of laboratories of the Elyria division of the Pfaudler Company since June, 1925 and has been associated with various phases of this Company since 1912. Mr. Poste has been a member of the SOCIETY since 1912 and has been active in the Enamel Division work of which he was chairman for two years. He also served as chairman of the Northern Ohio Section for two years.

Solon Shedd, Professor of Geology and Head of the Department of Geology, has left Pullman, Wash., and has become associated with Stanford University.

Edward J. Vachuska, who last year was Assistant in the Department of Ceramics at Rutgers College, is situated with the Bureau of Mines Ceramic Experiment Station, Columbus, Ohio.

RESOLUTION BY BOARD OF TRUSTEES

Employment of Technical Men in Public Positions

The Board of Trustees of the AMERICAN CERAMIC SOCIETY presents the following resolutions:

WHEREAS: It has frequently come to attention that public positions and offices requiring engineering or technical training, skill and experience are often filled with persons wholly lacking in such qualifications; and

WHEREAS: Such practice is inimical to and not in the interest of public policy and well being, the protection of life, health and property;

Therefore, be it Resolved: That AMERICAN CERAMIC SOCIETY urgently recommends that public positions and offices requiring engineering or technical training, skill and experience be filled only with technically qualified persons, and

Be it Further Resolved: That all state and local engineering and technical societies be urged to coöperate with the public to obtain such proper officers.

PROPOSED AMENDMENT TO CONSTITUTION

All papers, discussions and other writings which may be of interest or value to the SOCIETY if published, and which have been presented to a general session of the SOCIETY, shall become the property of the SOCIETY and their publication and other disposition shall be in the hands of the Committee on Publications.

No paper, discussion or other writing which may be of interest or value to the SOCIETY if published which has been presented before a division or local section shall be offered for publication elsewhere until the Committee on Publications shall have had the option of accepting the same for use in the *Journal of the American Ceramic Society.*

No committee reports prepared by a committee of the SOCIETY or of a Division or Local Section shall be offered for publication elsewhere until the Committee on Publications shall have had the option of accepting the same for use in the *Journal of the American Ceramic Society.*

L. E. BARRINGER
Chairman, Committee on Rules

JOINT COMMITTEE ON FOUNDRY REFRACTORIES

This meeting, as scheduled, was held on September 14th, at Mellon Institute, Pittsburgh, and the following were in attendance:

Mr. C. N. Ring, representing the Electrical Steel Founders' Research Group and the American Foundrymen's Assn.; Mr. J. L. Cummings, The S. Obermayer Co., Chicago, representing the American Foundrymen's Assn.; Mr. G. A. Bole, Bureau of Mines, representing the Bureau of Mines; Mr. W. J. Corbett, Secy. Steel Founders' Society of America, representing the Steel Founders' Society of America; Mr. H. R. Colwell, Division of Simplified Practice, Department of Commerce, representing the Division of Simplified Practice; Mr. J. T. MacKenzie, metallurgist, American Cast Iron Pipe Co., representing the American Electro-Chemical Society; Mr. M. C. Booze, representing American Refractories Institute; Mr. L. C. Hewitt, representing Committee on Coöperation, Refractories Division, AMERICAN CERAMIC SOCIETY.

At this meeting the writer was elected permanent chairman of the group and Mr. J. L. Cummings, secretary. Sub-committee chairmen were appointed as follows:

Simplification of Standardization of Shapes—Mr. W. J. Corbett.

Tests and Specifications—Mr. M. C. Booze.

Service Conditions—Mr. C. N. Ring.

Further sub-committees will be appointed under the direction of Mr. Ring relative to determining service conditions in various branches of the industry, such as the iron foundries, steel foundries, non-ferrous, etc. The complete personnel of these various committees has not been fully decided upon and the selection of these members will be left to the various sub-committee chairmen, the work to be eventually tied in through the Joint Committee and its Chairmen.

As will be ascertained from the above, it is hoped that this group will standardize refractory shapes for use in foundries, such as sleeves and nozzles, runner brick, cupola blocks, bung brick, etc., to make industrial survey of the conditions present as affecting refractory service, leading up to testing of such refractories as are used in the foundry industry, the entire work being correlated eventually into specifications covering refractories for foundry use.

OUR NEW HONORARY MEMBER

Twice the members of the AMERICAN CERAMIC SOCIETY have toured Canada visiting ceramic plants and being entertained by the Canadian ceramic manufacturers. On both of these occasions the members of this SOCIETY were impressed by the effective organization and collaboration of the ceramic interests in behalf of ceramic research and education. It was very evident that behind all of this there must be a directing and propelling force. This force was found to be in the Canadian National Clay Products Association.

The Canadian National Clay Products Association has on its roster and as its executive force and committeemen manufacturers of large financial investments. These men are members of technical societies and associations in the States; many of them are graduates of universities, several of the "school of hard knocks," but with ambition to study and achieve. It is no wonder that the Canadian National Clay Products Association has grown in strength and in productiveness, and it is not surprising to find this Association ready to a man, in not only personal support but in assessed financial support of a school of ceramics in the University of Toronto.

Canada now has two schools of ceramics, one at the University of Saskatchewan

and the other at Toronto University. Credit for these two schools is traceable to the Canadian Association.

As it is our aim to recognize the earnestness, the solidness, and the effectiveness of this Clay Products Association, the Board of Trustees at the last summer meeting voted to confer honorary membership on Mr. Gordon C. Keith, Secretary-Treasurer of the Canadian National Clay Products Association. Mr. Keith has continued since 1914 as Secretary of this Association, always alert to those enterprises which would advance the art and technology of ceramic manufacturing in Canada. Mr. Keith personifies the broad-mindedness and the progressiveness of the several members of this Association, and in electing him as honorary member of this SOCIETY it was intended that this should be in recognition of the quality of services rendered by the members of the Association, of which he is the continuing officer.

Gordon C. Keith was born in Smiths Falls, Ontario where he attended the Public School and Collegiate Institute, graduating in 1899. He attended Queen's University of Kingston, Ont., graduating with the degree of Bachelor of Science in Civil Engineering in 1907, Bachelor of Science in Mechanical Engineering in 1907 and Master of Science in Mechanical Engineering in 1911.

GORDON C. KEITH

He worked in the machinery department, cost and superintendent's offices of the Frost & Wood Co., Ltd., Smiths Falls, and the cost department of the Canadian Locomotive Works, Ltd., Kingston. He was editor of *Canadian Machinery, Power House and Canadian Foundryman.*

At present, in addition to being secretary-treasurer of the Canadian National Clay Products Association, he is editor and manager of *The Canadian Manufacturer* and secretary-treasurer and a director of The Commercial Press, Limited.

The Canadian National Clay Products Association was organized by the late Jonas Cornell of H. C. Baird & Son, tile manufacturers, in 1900. The first convention was held at London in 1901 when B. E. Bechtel of the Bechtel Brick & Tile Company was elected the first president.

Mr. Keith first became connected with the C.N.C.P.A. in February, 1912 when he read a paper on Power Problems of Clay Products Manufacturers at the tenth annual convention. He was then editor of *The Canadian Clayworker* which ceased publication during the war when the brick business was at a standstill. He was elected as member of the executive committee at that convention and in 1914 succeeded John R. Walsh as secretary-treasurer.

The C.N.C.P.A. has taken a great interest in education and the development of the industry in general, its latest achievement being the establishment of a course in Ceramics at the University of Toronto. The trustees in charge of the course are Ryland H. New, Chairman, Wm. Burgess, Harold F. Dingledine, and Gordon C. Keith.

In 1924 Mr. Keith was elected an honorary life member of the National Brick Manufacturers' Association, and an honorary life member of the Canadian Association of Stationary Engineers.

Mr. Keith is interested in flowers and is a member of the St. Clair Horticultural Society and a life member of the Ontario Gardeners' and Florists' Association. In summer he finds time to spend some time fishing at his summer home on the Rideau Lakes.

OUR 1926 ANNUAL MEETING

Next February during the week of the 8th this SOCIETY will be guests of the ceramic people of the South, particularly of Georgia. The Meeting will be in Hotel Biltmore, Atlanta, the first three and a half days and the excursion trip for plant and material deposits inspection will be in and about Macon, Gordon, McIntyre and Stevens Pottery, the clay deposits at Butler and at Augusta are well worth seeing. A week is too short a while to go all places where there are things of value to see. The meeting place and the inspection route were selected as giving a good idea of what the South has of interest to ceramists.

If time could be spared delegates are advised to stay over to visit the clay plants in Augusta and Butler, Ga., and also the clay, feldspar and other mineral deposits in North Carolina, Tennessee, Alabama, Mississippi, Kentucky and Florida.

The Southern states are rapidly being populated thus giving a growing home market. They have fine shipping facilities, a vast variety of ceramic materials and good labor. Industrially, the South is growing. To miss this Annual Meeting and the plant inspection trip through Macon and Wilkinson county one would be losing an opportunity of getting on a specially scheduled program and at two-thirds the usual cost, a first hand knowledge of this rapidly developing ceramic district. The Florida boom with its attending large building and equipping reaches the Southern factories and what is going on in Florida is duplicated in much of the South. Industrially and ceramically the Southern states are arriving with full steam on. You cannot afford to miss this opportunity to see the South in a clubby fashion through not only your own eyes but also the eyes of the other 800 ceramists who will be with you.

The seven Divisions already have their technical programs well in hand and papers are being pledged. Some of the papers are already in. The exhibit committee is ready with their announcements and even in advance they are being asked for space reservations. The local committee will have had their final meeting on September 24 but already they have pledged assurances of automobiles, special trains and entertainments. The local committee is all set and "rarin" to go and it is a very novel and instructive time they have planned. We are going to have a spirited, spiritual and inspiring time. Even General Lee on Stone Mountain is ahorse ready to show you his gallant troops in marching array. Your enlistment time is now. Write the Secretary of your Division about the papers you will read or wish to hear read.

Remember—Atlanta is not far distant from your place. Most of the 800 delegates will travel less than a day to reach Atlanta. You will then know why Georgia School of Technology, North Carolina State College and Tulane University have ceramic courses and laboratories, and why University of Louisiana and Missouri are planning for similar ceramic schools.

PITTSBURGH LOCAL SECTION MEETS OCTOBER 7[1]

The Pittsburgh Local Section of the AMERICAN CERAMIC SOCIETY is holding its first fall meeting at the Mellon Institute on Wednesday, October 7.

F. C. Binnall, Fuel Engineer of the Standard Sanitary Mfg. Co., is to give a talk on "Fuels" or some related subject.

This paper and discussion will be of interest to the enamel men in the vicinity of this section.

[1] H. F. Robertson, Secy.

OBITUARY

Benjamin F. Carter

Word has been received of the death of Benjamin F. Carter of Bartonville, Illinois. Mr. Carter had been a member of the SOCIETY since 1917 and was affiliated with the Heavy Clay Products Division.

Carl D. Bossert

Carl D. Bossert of Columbus, Ohio, died very unexpectedly in Mexico, Mo., Saturday, Sept. 12, 1925. Mr. Bossert had been enjoying especially good health, but suffered a sudden attack of hay fever—his death resulting at a local hospital from heart failure.

Mr. Bossert, who was 41 years of age and a graduate of the department of Civil Engineering at Ohio State University, was closely identified with engineering work in Columbus for a number of years. For the past three years Mr. Bossert had been serving as a field engineer for Carl B. Harrop, Engineers and Constructors, and during that period has had charge of construction work in Michigan, California, New York, Ohio and, at the time of his death, in Missouri.

Besides being an excellent engineer, Mr. Bossert possessed a very amiable disposition, which enabled him to get along especially well in the handling of his chosen line of work.

Mr. Bossert's home was in Washingtonville, Ohio, near Salem, where he was buried Sept. 15, 1925.

A LIFETIME OF WORK IN CERAMICS

Dean Earle J. Babcock, University of North Dakota

BY THOMAS F. KANE[1]

The Ceramics work in the Northwest suffered its greatest loss in the death of Dean Earle J. Babcock[2] of the University of North Dakota, which occurred September 3, 1925.

Dean Babcock's administrative work covered the College of Engineering and the School of Mines. A large part of his attention personally as an investigator and research worker was on the clays and coal of North Dakota. The field of investigation and development was so vast that he had a rather large number of workers associated with him. All of these workers take pride in recognizing Dean Babcock as the directing head and the inspiration of all the work planned and carried out in these two great fields.

The clays in the state, he revealed, are almost inexhaustible in quantity, just as he showed by his investigation and the geological surveys that the coals of the state are measured in the billions of tons. In quality he showed through chemical analysis and laboratory manufacture that the clays are so pure as to lend themselves to manufacture into all of the commoner clay products and the finer wares without any admixture of other clays or substances.

Before the time of his death he had attained two of the great objects of his work with clays. He had demonstrated so that it is becoming known that the clays are one of the greatest and most valuable resources of our state. The other was that in his enthusiasm for the work he had organized about him a group of workers capable of carrying forward for a long time to come the experiments and development that could be forseen and projected.

---

[1] President Univ. of N. Dak.

[2] For photograph of Dean Babcock see page 565, *This Bulletin.*

The laboratory work in Ceramics has been for fifteen years in charge of Miss Margaret K. Cable, a member of the AMERICAN CERAMIC SOCIETY, who commonly represented the University's clay work at the annual meetings of the SOCIETY.

Dean Babcock's death is a great loss to the interests of Ceramics, as it is to his university and to his state. His services, however, to Ceramics, as to his university and to the state, have been of such a nature as to project themselves far into the future to the permanent advantage of Ceramics.

Death of Carlton Geist

Word has just been received of the death on August 25 of Carlton Geist, President of the Geist Manufacturing Company of Atlantic City, N. J. Mr. Geist had been a member of the AMERICAN CERAMIC SOCIETY, as representative of his corporation, since 1924.

ART DIVISION QUESTION BOX

1. Is there a light firing clay which fires dense at cone 1, for example, and where may it be bought prepared for studio or school use?

DISCUSSION: The clay supplied by the Western Stoneware Co., Monmouth, Ill., fires to a light cream color and when glazed and fired to cone 1 to 2 is impervious.

The Sioux City Brick and Tile Co., Sioux City, Iowa have a good light firing clay which matures around cone 1 and is very plastic.

Many clays found around Chicago and the lower end of Lake Michigan fire buff and mature at cone 1 or even a little lower. However, they lack plasticity but the addition of 10% of bentonite overcomes this drawback.

The Indiana shale clay used by the Chicago Terra Cotta plants is buff firing and dense at cone 1.

2. Where do such schools as are listed below purchase their clays?

DISCUSSION: Alfred University, Alfred, N. Y. uses "Wescco" clay, sold by the Western Stoneware Co., Monmouth, Ill.

The Art Institute of Chicago gets most of its clay from the Mason City Brick & Tile Co., Mason City, Iowa. It fires red, comes dry and must be washed and prepared. Pottery made from this clay is waterproof when glazed and fired to cone 04.

The Cleveland School of Industrial Art uses Monmouth clay.

Lewis Institute, Chicago, uses a stoneware clay which is purchased and prepared in such large quantities that they are enabled to furnish prepared clay to other educational institutions at a reasonable price.

The Newcomb School of Art, New Orleans, obtains its clay from local sources.

The Museum School of Industrial Art, Philadelphia, uses Tuckahoe clay which it obtains from Wm. G. Moore and Co., Philadelphia.

Schenley High School, Pittsburgh, purchase their clay from the MacNichols Pottery Co., East Liverpool, Ohio. It comes plastic, fires light yellow and should be biscuited around cone 2.

The University of North Dakota is supplied by the Hebron Brick Co., Hebron, N. Dak., and the Dickinson Brick Co., Dickinson, N. Dak. These clays come dry, fire to a light cream color and are very plastic.

3. I have had difficulty since the war in securing flat potters' sponges. Where may they be obtained?

DISCUSSION: The best place to purchase such sponges is a wholesale drug concern. Myer Bros., St. Louis, carry a good grade of soft flat sponges.

4. What is the relative difference in the cost of purchasing glazes ready for use and making up one's own, provided one has the equipment?

DISCUSSION: If equipment for grinding is available it is considerably cheaper to make glazes rather than to buy them ready for use.

The following cost figures are approximate. They are based on current quotations on glaze materials in small quantities such as the individual or school potter would buy. In large quantities all materials, are of course, less expensive. These figures cover cost of materials only. Power and labor involved in grinding and preparation would be an additional expense varying according to conditions. Three typical glazes for cone 04–02 have been figured out in five colors as shown in table.

TABLE SHOWING COSTS PER POUND FOR MATERIALS ONLY

Typical raw glazes, cone 04–02	White or colorless	Blue	Green	Brown	Dull yellow	Bright yellow	Average list prices of similar glazes on the market
Matt glazes	0.10	0.12	0.11	0.11	0.11	0.20	$1.00 to 1.23 per lb.
Transparent lead glaze	.09	.12	.10	.10	.10	.18	$0.60 to 1.23 per lb.
Tin enamel (Majolica)	.13	.17	.14	.14	.14	.20	$0.75 to 1.50 per lb.

ARTHUR E. BAGGS

5. Is there any way that a porous biscuit body may be made waterproof except by glazing?

DISCUSSION: The suggestion has come in from several sources that a piece of biscuit ware may be rendered impervious by immersing it in a bath of hot paraffine or by coating it with a waterproof varnish or shellac. The piece may be decorated with dye, water color or oil paint prior to the treatment.

6. Where can a red firing clay be purchased in small lots, say 500 to 2000 lbs., washed, screened and plastic ready for use? How many would be interested in securing such a clay if some one could be found who could furnish it?

7. Wanted a brief description of a frit kiln suitable for small production such as needed in a school.

NOTES AND NEWS

THE FIRST HIGH SCHOOL CERAMIC COURSE

East Liverpool Has It

The ceramic manufacturers of East Liverpool, with federal and state aid, have established courses in ceramics to be taught in the East Liverpool High School. Kenneth M. Smith is the instructor. Behind him as co-workers and as an advisory board are C. C. Ashbaugh, J. M. Manor, Edwin L. Cawood, H. B. Barth, W. T. Blake, A. V. Bleininger, R. V. Miller and J. W. Hepplewhite.

The following two courses are to be opened October 1.

VOCATIONAL CERAMICS

Freshmen 1st Sem.	Hrs.	Credit	2nd Sem.	Hrs.	Credit
General Science	5	1/2	Phys. Geog.	5	1/2
English	5	1/2	English	5	1/2
Algebra	5	1/2	Algebra	5	1/2
Ceramics	15	5/8	Ceramics	15	5/8

Combined Laboratory and Shop Project

Sophomores 1st Sem.	Hrs.	Credit	2nd Sem.	Hrs.	Credit
English	5	1/2	English	5	1/2
Business and Acct.	5	1/2	Business and Acct.	5	1/2
Spec. Phys.	5	1/2	Spec. Chem.	5	1/2
Ceramics	15	5/8	Ceramics	15	5/8

Combined Laboratory and Shop Project

Juniors 1st Sem.	Hrs.	Credit	2nd Sem.	Hrs.	Credit
English	5	1/2	English	5	1/2
Pl. Geometry	5	1/2	Pl. Geometry	5	1/2
Commerce and Ind.	5	1/2	Industrial History	5	1/2
Ceramics	15	5/8	Ceramics	15	5/8

Combined Lab. and Shop Practice

Seniors 1st Sem.	Hrs.	Credit	2nd Sem.	Hrs.	Credit
Amer. History	5	1/2	Civics	5	1/2
Economics	5	1/2	Management	5	1/2
Mech. Drawing	5	1/2	Mech. Design	5	1/2
Ceramics	15	5/8	Ceramics	15	5/8

Combined Lab. and Shop Practice

College Preparatory

Freshmen 1st Sem.	Hrs.	Credit	2nd Sem.	Hrs.	Credit
English	5	1/2	English	5	1/2
Algebra	5	1/2	Algebra	5	1/2
Language	5	1/2	Language	5	1/2
Gen. Science	5	1/2	Gen. Science	5	1/2

Sophomores 1st Sem.	Hrs.	Credit	2nd Sem.	Hrs.	Credit
English	5	1/2	English	5	1/2
Algebra	5	1/2	Pl. Geometry	5	1/2
Language	5	1/2	Language	5	1/2
Ancient and Med. Hist.	5	1/2	Ancient and Med. Hist.	5	1/2

Juniors 1st Sem.	Hrs.	Credit	2nd Sem.	Hrs.	Credit
English	5	1/2	English	5	1/2
Pl. Geometry	5	1/2	Solid Geom.	5	1/2
Physics	7	1/2	Physics	5	1/2
Ceramics	15	5/8	Ceramics	15	5/8

Combined Lab. and Shop Practice

Seniors 1st Sem.	Hrs.	Credit	2nd Sem.	Hrs.	Credit
Amer. History	5	1/2	Civics	5	1/2
Spec. Chem.	7	1/2	Economics	5	1/2
Mech. Drawing	5	1/2	Machine Design	5	1/2
Ceramics	15	5/8	Ceramics	15	5/8

Combined Lab. and Shop Practice

Eighth Grade Graduates Eligible.

Night Schools

Night schools for adults will begin about October 15 and run for twenty-four weeks. Messrs. Bleininger, Hepplewhite and Miller have conducted such night schools for two years in Newell, W. Va. These experts will instruct with Mr. Smith in the night school.

None of the work of this school will replace the apprentice system now operating in the several ceramic plants.

The board of education has ordered that the former chemistry and laboratory rooms of the Central School building, Fourth Street to be remodeled and used for this purpose. The floors of these rooms are to be cemented.

The raw material needed will be contributed by local potteries. This includes clays as well as brick. The manufacturers have also agreed to fire the ware made free of all cost to the pupils and the school board.

F. Q. Mason, color manufacturer and the Joseph Croxall Chemical Company are to present all colors, oxides and chemicals.

Machinery to be Installed

The machinery will be secured from the Patterson Foundry and Machine Company. It will consist of a motor-driven laboratory pebble mill, a motor-driven testing outfit, a motor-driven 3″ pan, a motor-driven friction jolley and pulldown, a nine and one-fourth ring for the same, a flat disk for throwing and two bench whirlers. Other materials of a smaller nature, which will include various tools, wiring, tanks, mortars and pestles and other accessories will send the total cost up to about $3000. Of this sum, the Patterson Foundry and Machine Company as its contribution "toward the educational work for the benefit of the children of the community" has donated the sum of $1000.

KENNETH M. SMITH

The local manufacturers have raised a sum of over $4000 to initiate the work of this school and plans are made to furnish the means locally and by state aid to permit the school to develop vocationally and in ceramic art to whatever the local industrial needs may dictate. A close collaboration with the Ohio State University ceramics department has been assured.

Being the first high school course in ceramics it is novel and without precedent. No one can foresee its future, but no effort will be spared to make of it all that it may be by money, enthusiasm and industrial support.

History of K. M. Smith

Kenneth M. Smith was raised in Tama, Iowa. He is 30 years of age, married and has two children. He was graduated from Iowa State College under Prof. Cox in 1924, and has for the past year served as ceramic engineer at the Cambridge Sanitary Manufacturing Company.

Those Served by the School

E. L. Heusch, vocation director of Ohio said to the East Liverpool advisory and financial committee with whom he met recently, "You are destined to see great things accomplished by reason of this departure. We have too long neglected the boy who for some reason or another quit school before securing a sufficient education with which to compete with his fellows in this material age in which we are living. Of 100 pupils who enter high school but 13 graduate. Of the 13, but 7 go to college. And of these 7 but 3 actually graduate from college. What of the 87 who never finished high school? They ultimately make up our workers and producers. Now in Ohio we have for some

time been out to help such as they. You are doing that very thing by this move in East Liverpool. We want as few handicapped persons in the world as possible. We should make it possible for all to partake of the inscription on a certain Ohio high school: 'That all youth may have a higher person life.' "

CERAMIC MODELING TAUGHT

By The Art League of Ellwood City

This league is practically in its infancy, only having been started one year ago last February through the Women's Civic Club. This Club held an art exhibit, renting paintings from various sources. In the collections were works of well-known artists, also a few bronzes. To these were added the works of local artists, paintings, pencil sketches and similar work done by students at school and a few architectural drawings executed by a couple of Pittsburgh Tech. students. The exhibit was held for one week. A fashion show was also put on and a talk by Mr. Taylor, head of the Painting and Decorating Department at Carnegie Tech., Pittsburgh, was given which proved most interesting.

It was a great surprise to everyone to find such a large number of people in Ellwood City who were interested in painting, so it was suggested by the Chairman of the Art Committee of the Women's Civic Club that a league be formed. Mrs. A. T. M. Thomas effected the organization and fostered it the first three months.

B. L. WATKINS

Matthew M. Riley was elected President, Louise Barton, first Vice-President, Phillis Charles, second Vice-President and Lewis Nickum, Secretary-Treasurer. The Vice-Presidents were supposed to act as heads of various committees as the different kinds of work came up. The organization was small, about fifteen members. Their aim was to improve themselves and finally to stimulate the interest of the community in Art. In May last year another exhibition took place of work done in the Pittsburgh public schools. The art director, Mr. Boudreau, lectured on the value of art in the public schools, a very fine and stimulating address. Several people expressed a wish to study clay modeling, so Miss Louise Barton, the fervent and energetic first Vice-President, at once set about organizing a class for this work in January.

The general manager of the Shelby National Tube Co., at Ellwood, James Dunn, and Matthew Riley of the same corporation, forthwith acted as sponsors and this class is so far maintained by them. The equipment was furnished by the Shelby Tube Co.

and the class is held in a well-lighted, airy basement of the Shelby Social Club. The class was primarily formed for school children and only a small fee is charged. One of the objects is to give the youngsters a useful occupation on Saturday afternoons, and to help to increase their powers of observation, love of form and beauty, an ability to appreciate all of the arts and to single out the very occasional person with special aptitude.

The services of Bertram L. Watkins of New Castle were obtained as instructor. He is the specialist in modeling for sanitary casting and has charge of the modeling and moldmaking departments at the Universal Sanitary Manufacturing Co.

Hailing from England his apprenticeship and training as modeler to the famous English pottery firm of Messrs. Josiah Wedgwood & Sons, Etruria, Stoke-on-Trent and Messrs. Howson & Sons, Sanitary Manufacturers, Hanley, also twleve years study in the Schools of Art gave him both the practical and artistic sides, and this has been appreciated by a most enthusiastic class. There are at present twelve juniors and six seniors. The class is held Saturday afternoons and the adult session on Wednesday evenings. Great progress has been made from quite simple objects to the more difficult casts and several adults have quite good examples of their work in the studies of flowers, fruit and heads.

It is intended to hold an exhibition of the work done in the fall.

VOCATIONAL AND APPRENTICESHIP SCHOOL AT ONONDAGA POTTERY[1]

At the present time the training work in this school is confined to young men in the Clay Shop. In the Clay Shop they have three grades:

First, the boys under seventeen, who by New York State Law are required to attend Continuation School four hours a week, are given Continuation School training within the factory, two hours a week being devoted to the simpler processes of forming ware and two hours to school work which embraces in an elementary way mathematics, English, civics and hygiene.

Second, boys over sixteen who have shown special aptitude are permitted to enter our Elementary Apprenticeship Training Course. To enter this a boy must sign a contract agreeing to remain in the employ of the company and to faithfully perform his work for a period of six months. Of course, this contract is not legally binding on the boy, but it is understood that if he does not keep his word he is given no further consideration by the Onondaga Pottery Company. In this contract the company agrees to give the boy two hours' training a week in the various processes in making ware. This training is given by skilled Clay Shop employees. In addition, the boys in the Elementary Apprentice Training Course, who are of Continuation School age, are given the same school work as the Continuation Shool boys receive. The State Educational authorities recognize our Elementary Apprentice Training Course equivalent to the Continuation School course. The boys in this course are graded and if their grades are satisfactory they receive a small cash reward each week; in addition they receive at the end of the six months a cash reward, depending upon the grade which they have averaged in their work in the course. After a boy has completed the first six months, and if he seems sufficiently promising, he is allowed to sign a similar contract for another six months. At the conclusion of the year's training, if his grade has been satisfactory, he receives a diploma as a graduate of the Clay Shop Elementary Apprentice Training School.

[1] A statement by R. H. Pass.

The boys in both the Continuation School classes and in the Elementary Apprentice Training Course are paid at their regular rate for the time spent in this work. They take it seriously and unquestionably profit from it. The general improvement in the class of boys in the Clay Shop has been very marked since we started this work.

In addition to the Elementary Work covered above, we have an Advanced Apprentice Training School in the Clay Shop, which is open to promising boys over eighteen. Preference is given the most successful graduates of the Elementary Course. This is equipped with regular production machinery and is segregated, being under an instructor who is a thoroughly good potter. In this school the boys put in full time, receiving just enough per week to cover living expenses. Here they go through the various processes of pottery making, spending most of the time in jiggering and the batting-out and finishing, which go with it. In addition to the Vocational Work, these boys receive every week a half day in special instruction—mathematics, civics, History of Potting, and, above, all, a series of lectures, given where the work is done, by the heads of the various departments, to explain the whole process of production and show the boys the important part their work plays in the long sequence of operations necessary to make the finished product. We find that it takes about fifteen months for a promising young man to do the work required in the Advanced Course. At the conclusion of the course, he receives a diploma stating he is a Journeyman Potter, and he receives also a prize in the form of an especially fine piece of pottery ware.

It has been very gratifying to notice the attitude of our older men toward the training work outlined above. Apparently they are glad to see steps taken to put a stop to the demoralization of their trade and to develop potters whose work is worthy of the traditions which the older men have created here.

NOTES FROM THE CERAMIC SCHOOLS

Before these notes are read ceramic schools will have opened their doors to students. Increased facilities in some instances and changes in instructional personnel in other give a new set up for the year. The schools belong to "the people" in general and to ceramic manufacturers in particular. The purpose of the following notes is to keep the schools and the instructors known.

R. J. Montgomery to University of Toronto

The Board of Governors of the University of Toronto has appointed R. J. Montgomery as Lecturer in the Department of Metallurgical Engineering, this to be a beginning of the Department of Ceramic Engineering to be established at that University. The work is being started at the request of the Canadian National Clay Products Association and considerable aid is being given by that organization in financing the course.

R. J. MONTGOMERY

The ceramic work may be taken by fourth year engineering men as an elective. The course will consist of lectures, 3 hours a day, 3 days a week both first and second terms and 2 laboratory periods of 6 hours each every week during the second term.

Mr. Montgomery was graduated from the Ceramic Department of Ohio State University in 1911, and has held the following positions: Pittsburgh Plate Glass Co., Clay Research Laboratory, Creighton, Pa., 1911–15; in charge of the Refractories and High Temperature Division of H. Koppers Company's Laboratory, Mellon

Institute, 1916–17; in charge of the manufacture of glass pots and furnace refractories as well as technical development work, Bausch and Lomb Optical Co., Rochester, N. Y., 1918–25. Mr. Montgomery worked there with the porcelain type of pot for the more corrosive glasses and the development of new optical and spectacle glasses not being made in the United States.

S. R. Scholes

Dr. Scholes at Ohio State University

Samuel Ray Scholes, who has been secured as lecturer on technology of glass to ceramic classes at Ohio State University for the year 1925–26, was born at Marquette, Wis., in 1884. He received his A.B. degree from Ripon College in 1905 and from 1905–08 was instructor in chemistry and physics at Wausau, Wis.; from 1908–11 he was laboratory instructor and Loomis Fellow in chemistry at Yale University and in 1911 received his Ph.D. degree from Yale.

Dr. Scholes was Fellow at Mellon Institute 1911–15; Chemist, H. C. Fry Glass Co., Rochester, Pa., 1915–20; Assistant Director, Mellon Institute, 1914–17; Superintendent, Utility Glass Works, Lonaconing, Md., 1920–21 and since 1921 has been Chemist for the Federal Glass Company, Columbus, Ohio.

J. L. Carruthers

John L. Carruthers to Ohio State

John L. Carruthers was born in Colorado in 1895. He attended the secondary and high schools of Lafayette and Denver, Colo. and in 1921 received his B.S. degree in Ceramic Engineering from Ohio State University. Mr. Carruthers served in the Air Service, U. S. Army in 1918. Positions which he has held are as follows: Denver Sewer Pipe Co., summer, 1915; Plant engineer, Denver Terra Cotta Co., 1916–17; Construction engineer, Radium Co. of Colorado, summer, 1920; ceramic engineer, Denver Terra Cotta Co., 1921–22; construction and service engineer, Carl B. Harrop, 1922–25. Mr. Carruthers will be assistant professor in the department of ceramic engineering, Ohio State University for the year 1925.

A. I. Andrews

A. I. Andrews to Illinois

Dr. Andrews, who has been appointed Assistant in the Department of Ceramic Engineering, University of Illinois, was born in Baraboo, Wisconsin, 1895 and received his secondary education in the public and high schools at Oshkosh, Wis. He received his B.S. degree in 1920 and M.S. 1921 from the University of Wisconsin. While in residence at this University he acted as Assistant to Victor Lenher during the years 1920–22 and carried out

his research work under Dr. Lenher. In 1922 Dr. Andrews came to Ohio State University and assisted Dr. Evans, taking his major work under Dr. Withrow. In 1923 he was given the U. S. Bureau of Mines Fellowship at Ohio State University and in 1924 he received the degree of Doctor of Philosophy. Dr. Andrews for one year taught ceramics at Alfred University under the direction of Dr. Binns.

George Reed Shelton at North Carolina

George Reed Shelton, Assistant Professor of Ceramic Engineering at North Carolina State College, attended Maryville College and later Cornell, where he received his A.B. degree in 1912. He received his M.S. degree in Ceramic Chemistry at the University of Illinois, 1920 and his Ph.D. in Ceramic Chemistry from the same University in 1922. Dr. Shelton taught chemistry and physics at Mitchell High School, Mitchell, S. Dak., 1912–16; was Associate Professor of Chemistry at Maryville College, 1916–18; Research Assistant at the Engineering Experiment Station, University of Illinois, 1918–20; Corning Glass Works Fellow, University of Illinois, 1920–22. From 1922–25 he was chemist and petrographer at the University of Saskatchewan for the Engineering Institute of Canada.

George R. Shelton

Dr. Shelton's research work for his Ph.D. was done on the viscosities of soda-lime-silica glasses at high temperatures and was carried out under the direction of E. W. Washburn. His work at the University of Saskatchewan was on the deterioration of Portland cement in alkaline soils. At North Carolina State College, Dr. Shelton will conduct classes on cements, lime, glasses, enamels and whiteware.

The new ceramics building at North Carolina State College which will contain classrooms, offices, laboratory, machine room and kiln room will not be completed in its equipment before January 1.

An enrollment of between 15 and 20 students consisting of freshmen, sophomores and juniors is indicated from the applications.

Preparations are being made for the second annual short course in clay working and ceramics to be held in January. This course will be devoted entirely to heavy clay products.

Walter A. Preische

Receives Appointment at Penn State

Walter A. Preische, a graduate of Alfred University as Bachelor of Science in Ceramic Engineering in 1924, is now a member of the faculty in the Ceramic Department of the School of Mines at Pennsylvania State College. Since graduation he held the position as production manager for the Shawmut Brick and Tile Company in their plants located at Shawmut, Penna. Later he became head of the Department of Mathematics of Oyster Bay High School, Oyster Bay, N. Y.

DEPARTMENT OF COMMERCE NOTES

The Concentration of Fluorspar Ores An investigation to determine possible improvements in the milling of fluorspar is being conducted at Rolla, Mo., by the Bureau of Mines, Department of Commerce. A study has been made of tailings from concentrating mills in southern Illinois, and the material was subjected to experimental classification, and concentration with jigs and tables in order to determine its behavior. Sufficient progress has been made to indicate that considerable improvement in concentration and more economical recovery may be effected.

Firing Ceramic Wares with Oil There is a wide demand for information on the efficiency of oil as a fuel for firing ceramic wares. A complete survey of all ceramic plants known to use fuel oil has been completed by the Bureau of Mines, Department of Commerce. The results show that oil is an excellent fuel for this purpose, because the fires can be kept clean, there is no trouble from smoke, and the temperature of firing can be closely regulated, all of which tends toward efficient burning with a resultant saving in fuel and labor.

Load Tests for Refractories In the construction and operation of metallurgical and industrial furnaces, it is highly desirable to have accurate knowledge as to the load refractories will carry without deformation when heated to the intense temperatures developed in the furnace. Therefore, the ceramics experiment station of the Bureau of Mines, Department of Commerce, in coöperation with Ohio State University, has been conducting an intensive study of the effect of furnace conditions on the so-called load test for the limit of strength of a refractory. This work, now brought to a close, has yielded fundamental data on the effects of temperature, time of heating, rate of increase of temperature, and other factors affecting the physical condition of the brick. These data have been reduced to simple charts and diagrams, so the furnace operator can easily follow the reactions that may be expected for various conditions of operation, for a large variety of refractory materials.

CALENDAR OF CONVENTIONS

Organization	Date	Place
Am. Assn. Advancement of Science	Dec. 28–Jan. 2	Kansas City, Mo.
AMERICAN CERAMIC SOCIETY		
(Annual Meeting)	Feb. 8–13, 1926	Atlanta, Ga.
(Fall Meeting)	Oct. 1, 1925	New York City
Am. Engineering Council	Jan., 1926	
Am. Foundrymen's Association	Oct. 5–9, 1925	Syracuse, N. Y.
Am. Gas Association	Oct. 12–16, 1925	Atlantic City, N. J.
Am. Soc. of Mechanical Engineers	Nov. 30–Dec. 3, 1925	New York City
Am. Zinc Institute	April 27–28, 1926	St. Louis, Mo.
Coal Mining Institute of America	Dec. 9–11, 1925	Pittsburgh, Pa.
Common Brick Manufacturers Assn.	Feb. 22–26, 1926	New Orleans, La.
Mining and Met. Society of America	Jan. 12, 1926	New York City
Natl. Association of Manufacturers	Oct. 26–28, 1925	St. Louis, Mo.
Natl. Brick Manufacturers Assn.	Nov. 2–7, 1925	St. Louis, Mo.
Natl. Exposition of Power and Mechanical Engineers	Nov. 30–Dec. 5, 1925	New York City
Natl. Exposition of Chem. Industries	Sept. 28–Oct. 3, 1925	New York City

Natl. Paving Brick Mfrs. Assn.	Jan., 1926	
Natl. Safety Council	Sept. 28–Oct. 2, 1925	Cleveland, O.
Optical Society of America	Oct., 1925	Ithaca, N. Y.
Sand-Lime Brick Association	Feb. 9–15, 1926	New Orleans, La.
Natl. Society for Vocational Education	Dec. 3–5, 1925	Cleveland, Ohio
Natl. Exposition of Coal Mining Machinery	Dec. 2–5, 1925	Cincinnati, O.

E. J. Babcock

Official Personnel of Divisions—1925-26

	Art	Enamel	Glass	Heavy Clay Products	Refractories	Terra Cotta	White Ware
Chairman Vice-Chairman Secretary	Mary G. Sheerer Margaret K. Cable H. Clinton Baldwin	M. E. Manson H. G. Wolfram	A. Silverman Herbert Insley A. N. Finn	John D. Martin Amos P. Potts	C. E. Bales R. F. Geller L. C. Hewitt	E. C. Hill W. J. Stephani G. M. Tucker	F. H. Riddle F. H. Rhead
Committee on Research	F. H. Rhead	H. F. Staley	E. W. Washburn	F. G. Jackson	R. F. Ferguson	H. G. Schurecht	A. V. Bleininger
Committee on Standards (*a*) Tests (*b*) Products	(*a*) C. F. Binns (*b*) F. H. Rhead	(*a*) E. P. Poste	(*a*) R. F. Brenner (*b*) A. E. Williams	(*a*) A. V. Henry (*b*) Hewitt Wilson	G. A. Bole	(*a*) C. W. Hill (*b*) W. L. Howat	(*a*) Geo. Sladek (*b*) Robert Twells, Jr.
Committee on Data	H. S. Kirk	T. D. Hartshorn	J. W. Cruikshank	R. E. Arnold	D. W. Ross	T. A. Klinefelter	E. Schramm
Comm. on Membership	W. W. Wilkins	R. A. Weaver	J. M. Hammer	R. A. Horning	C. F. Geiger	Geo. P. Fackt	Ira E. Sproat, *Chairman* Geo. Simcoe A. A. Wells
Committee on Rules	Arthur Baggs	R. R. Danielson	S. R. Scholes	W. D. Richardson	W. E. Dornbach	W. A. Hull	E. H. Fritz
Committee on Education	Edna P. Carson	R. D. Landrum	Henry W. Hess	H. R. Straight		A. F. Hottinger	
Rep. Comm. on Nominations	H. S. Kirk	R. R. Danielson	A. W. Kimes	Marion W. Blair	F. W. Donahoe	F. B. Ortman	Perry Forst
Councillors	Frederick Carder Paul Cox Jane Hoagland		F. C. Flint A. E. Williams G. E. Barton	O. J. Whittemore		W. H. Powell H. J. Lucas Atholl McBean	
Committee on Papers and Program	Myrtle M. French	J. E. Hansen	J. C. Hostetter H. Insley F. C. Flint	F. T. Owens	Louis J. Trostel	Oscar Mathiasen D. F. Albery H. E. Davis	C. C. Treischel F. H. Rhead T. A. Shegog
Comm. on Coöperation			James Gillinder	J. L. Child	L. C. Hewitt	P. G. Larkin	R. F. Geller Perry Helser Stephen Leech
Committee on Contact			W. M. Clark	G. A. Bole		R. N. Long	
Editor: Question Box	Margaret K. Cable		R. R. Shively		E. E. Ayars	Hewitt Wilson	
Committee on Exhibitions	Martha G. Westfeldt	W. V. Knowles	A. R. Payne	B. Mifflin Hood		B. S. Radcliffe	
Trustee	Paul E. Cox	R. R. Danielson	J. C. Hostetter	C. Forrest Tefft	J. S. McDowell	R. L. Clare	C. C. Treischel

BULLETIN

of the

American Ceramic Society

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

Vol. 4 November, 1925 No. 11

EDITORIAL

ALLOCATION OF BUREAU WORK ON CERAMICS

Field Laboratories and Plant Proving Should Be Continued

Both of the federal bureaus, Standards and Mines, have laboratories and research personnel devoted exclusively to ceramics. Both of these Bureaus are engaged in fundamental science and in empirical or applied science investigations; both are doing coöperative work with associations, corporations and individuals; and both Bureaus are increasing in services rendered and in need for larger support. It is well that the economy and effectiveness of this arrangement be studied.

Since both of these Bureaus are now in the Department of Commerce, Secretary Hoover has appointed a Committee to consider all phases of allocation of ceramic work in the two Bureaus. This Committee is holding hearings, and in November it will have a special session at which delegates from the several ceramic organizations are to be heard. The Committee is composed of industrial leaders in lines other than ceramics, hence decisions made will be impartial.

It is natural and not at all detrimental that each of these two Bureaus should not observe rigidly the limits set for each. A given amount of rivalry has been excellent. Competition is as vital to healthy development in research as it is in all other human affairs. The present arrange-

ment of having two Bureaus engaged in ceramic research each under separate direction is both practical and healthy but, theoretically, and perhaps, practically, it would be well to have all the ceramic work in the one Bureau if this can be done without stifling the ambitions of the bureau personnel which are now prodded by rivalry into doing their utmost.

The two Bureaus are now and always have coöperated in a friendly manner. They have exchanged information and given freely to each other on request. The rivalry between them has been similar to that between two friendly manufacturers who exchange manufacturing information but compete for territory and sales; both Bureaus have been on their toes producing results. The rivalry has been healthy.

What little overlapping there has been in work undertaken by each Bureau has not been detrimental and fortunately the ceramic industries have not suffered in results obtained because of encroachments by each Bureau on the field defined for each by the organic acts. The Bureau of Standards has been the aggressor in this respect but it has cared so well for the tasks undertaken but belonging to the Bureau of Mines that no one has thought of protesting. Indeed, "though out of order," their efficiency has justified the encroachment and the Bureau of Mines has ample scope not encroached upon. Both of the Bureaus have acquitted themselves in ceramics very admirably.

When it comes to transferring all of the ceramic work to one or the other Bureau, as Secretary Hoover has proposed, the ceramic industries have a just reason for protesting because neither Bureau is qualified to do the character of work to which the other one has been devoting the majority of its attention.

The Bureau of Standards is admirably qualified and situated to make investigations on standards, specifications of materials and products, and on simplification of product. They are better qualified to determine the fundamental or scientific facts regarding ceramic materials and products. Qualities and standardization and abstract science work in ceramics are so broad, untouched and important fields of endeavor that it would be well that every support be given by the ceramic industries to the Bureau of Standards in this work.

In glass, vitreous enamels and pottery Standards has large opportunities of rendering valuable service. Past performances in these fields warrant giving Standards a larger and better trained personnel. What they have accomplished has shown the value that would accrue from more intensive scientific work in these fields. If every energy, every thought and every cent that could be made available were devoted to work in these lines the Bureau of Standards would place America in the lead in these fields. To lessen their concentration on these investigations

by placement in Standards the ceramic work now being done by the Bureau of Mines would be defeating the very purpose for which the Ceramic Division of the Bureau of Standards is operated.

The Bureau of Standards, as stated in the last Annual Report of its Director, has organized its personnel for and has paid attention more to the fundamentals required by the ceramic industries. To these, as the Director states, the effort of the Bureau of Standards should be directed. To reverse this policy of the Bureau of Standards or to confuse it by enlargement so as to cover the ceramic work now being done by the Bureau of Mines would not only greatly lessen the effectiveness of Standards but lose the benefits now being derived by the ceramic industries from the Bureau of Mines.

The Ceramic Division of the Bureau of Mines has devoted its attention to mining, preparation, treatment and utilization of ceramic materials. It has studied the means of economically employing ceramic minerals. The beneficiation and industrial use of clays of Georgia and Ohio, of talc, cyanite and dolomite have been studied and carried through and proven in manufacturing.

Study of the economic use of coal and of oil in kilns was only started but the fundamental facts disclosed and the industrial proof made justifies continuance of these fuel studies.

The novel and distinctive work done by the Ceramic Division of the Bureau of Mines has been the proving on plant scale production and under plant conditions the determinations made in the laboratory. The Bureau of Standards has not and would not, without amendment of its policy, undertake plant proving of its investigations.

It has been questioned if this plant proving should not more properly be done by the industries. We believe not.

In the first place, the investigators, fundamental and applied, need the opportunity of bringing their work through to industrial applications, thus making evident to them the discrepancies in their findings, preventing malconceptions and showing the character of fundamental data most needed.

In the second place this plant proving checks the laboratory findings. No laboratory work, no matter how closely it might simulate plant conditions, can be trusted to develop all of the factors which must be controlled in economic plant production.

For instance, for years scientists and plant technologists have sought ways of making refractories from dolomite. Brick and slags standing excellently the laboratory tests and even proving well in trial use, have from time to time been produced. The results of several researches involving fundamental studies of the reactions, the compounds formed, the variations in product made by different heat treatments, the effect

and efficacy of various binders, etc., have repeatedly been considered as finally showing how refractories could be made from dolomite. It was not until the Ceramic Division of the Bureau of Mines made plant scale studies concurrently with their fundamental researches that any degree of success has been attained. No industrial concern independently has solved the problems, and the history of the work on dolomite in the laboratories and in the plants makes plain, we believe, that neither a federal bureau nor an industrial concern independently would have found the several factors and combinations of factors which affected the utilization of dolomite as a refractory. It has required men trained to do fundamental science research observing not only product qualities as affected by variation in plant practice but also product qualities in reference to conditions in use.

We believe firmly that if the government discontinues plant proving of its investigations the Bureau investigators will be less qualified to render service by their fundamental researches and that the industries would not and could not make plant application of the results of the fundamental researches made by the Bureaus.

Then, too, we believe in the federal bureau having stations located in the industrial centers. We believe in a great central laboratory for the fundamental researches leading to standards and specifications but not for application of science to the beneficiation and economic use of minerals and of ceramic products. We believe strongly in field stations and in the Bureau men proving their work under plant conditions.

We agree with Secretary Hoover in the possibilities of larger returns from concentrating all the ceramic work in one Bureau but we would urge strongly against discontinuance of field stations and employment of laboratory cars. Especially do we believe that the work of bureaus would be of much less value to the industries if the bureau men should discontinue plant proving of laboratory findings. We believe in economy and efficiency of the laboratory men carrying through to plant production basis rather than having the bureau men limited to laboratory investigations and depending upon technical men in the industries for proving and making application of the bureau results.

For altogether too many years have the bureaus been content with small scale empirical investigations, and for too long a while have they divorced the fundamental and the applied. We plead for plant proving by men capable of checking or finding the fundamental causes for behaviors of materials and products under plant conditions, and for the doing of this in field laboratories where the maximum of collaboration with the industrial technologist can readily be secured. We are not in favor of the government doing all of the ceramic investigation in one great central laboratory.

PAPERS AND DISCUSSIONS

THE MANUFACTURE OF LEADS FOR THE MECHANICAL PENCIL

By Robert Back

The fashioning of materials into marking leads is one of the oldest ceramic industries, yet practically all there is in the literature are brief references, and the formulas suggested are quite impractical. The literature contains little not found in encyclopedias. Recently some trade journals in this country and foreign countries have had narrative descriptions of processes for making the lead sticks and the wooden casings.

The mechanical pencil has revolutionized methods and formulas for making leads. The severe specifications of size and strength of lead for mechanical pencils make efficient production of them far more difficult than of lead for the ordinary, wood-encased pencil. The various hardnesses of lead for the ordinary wooden pencil results simply from variations in proportions of the materials and in the diameters employed. The diameter of the lead in mechanical pencils is of first importance in developing a practical formula.

The industry is purely ceramic, regardless of the kind of leads. Ceramic materials and many organic materials are used. A thorough understanding of the fundamental principles of ceramic materials and material compounding is necessary for successful lead manufacturing. Control has to be had of plasticity and binding power of the materials, and drying behavior, shrinkage and firing of the mixtures as well as of grinding, purifying, mixing, screening, filter-pressing and pugging.

Materials Used in Black Leads

The materials used in the manufacture of black leads are (1) a blend of plastic binding clays having definite working properties and firing behavior for the various degrees of hardness, (2) graphites, both flake and amorphous, blended according to the quality of leads desired.

The proportion of flaked graphite which can be used is limited. Even 300-mesh flake graphite reduces the binding power of the fine-grain plastic clays relative to the binding power of the same used with amorphous graphite. Especially is this an important consideration in the smallest diameter leads, those having a diameter of 0.0460 inches. Obviously, the larger the diameter of lead the higher can be the content of flake graphite. It is desirable to use as much flake graphite as possible for it imparts smoothness and ease of slip.

The clays and graphites used for black lead must be freed from all gritty material.

Colored Leads

For colored leads similar clays are used but their firing behavior is not important as colored leads are not hardened by firing. Gums, mineral waxes, vegetable tallows

and synthetic organic compositions are used to harden colored leads. Quite naturally, black graphites are not used in colored leads. The smoothness or ease of slip in colored leads is obtained from the finest ground talcs, micas and synthetic organic materials.

Mineral pigments and aniline dyes are used as coloring in the leads. Purity in case of some of the materials is of greater importance in the colored leads than freedom from grit is in black leads, because impurities interfere with the working and forming of the lead. The shrinkage and final strength and perfection are affected by certain impurities.

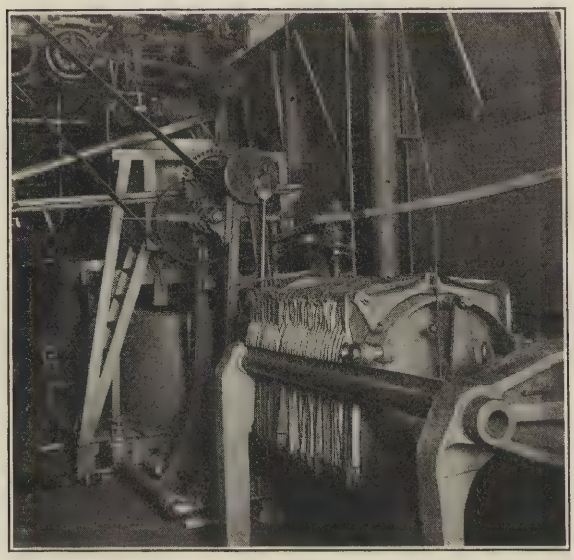


FIG. 1.

The manufacture of hardened colored leads for mechanical pencils is by far more difficult than the manufacture of equivalent fired black leads. Those colored leads which approximate the writing qualities of the fired black leads are the most difficult to manufacture to exacting size limitations, strength specifications, etc.

Manufacturing Processes

Leads of crayon composition and the larger diameter leads of high wax and grease composition are manufactured by a simple extrusion or by casting in molds.

Preparation of the Clays The clays are aged in storage to develop maximum plasticity and bonding power. They are made into slip by grinding in porcelain-lined pebble mills with deflocculating reagents. They are then pumped to a battery of thirty settling tanks. Satisfactory separation of the gritty material results after four to six days' standing.

Batch Mixing The grit-free deflocculated clay is syphoned to pebble mills where the graphite additions are made and the batch ground. The time for grinding is exceedingly important, and varies with the physical condition and the percentage content of the flake graphite in the batch.

On completion of the grinding, additional water is added to facilitate pumping and screening through 300-mesh phosphor bronze shaker screens. The tailings are returned to a tank below the pebble mill.

Filter Pressing and Pugging

Figure 1 shows an upper tank which serves as a batch storage. In the double blunger tank below it flocculating reagents are added to the batch. The batch is then thoroughly beaten to a uniform mixture.

The lead mixture for best writing quality presents a most difficult problem in filter pressing. It is plastic and compact. To press water from it is very difficult. As the pressure builds up in the press the impulse of the pump has to be reduced to a minimum, otherwise it would invariably break the cakes and cause the press to leak under the finishing pressures of 250 to 300 lbs. per square inch. To filter press lead mixtures successfully an automatic pressure regulator was designed. This regulator gives sufficient resistance against the pulsations of the pump to give satisfactory even flow even with pumps having excess capacities and reduced strokes. In the line to the press there is an extra large expansion chamber to further reduce pulsations.

Fig. 2.

The filter cakes are put through a vertical type pug mill. The material is extruded in the shape of plugs about 2 inches in diameter. Three or four trips through the pug mill give the desired uniformity in moisture distribution. The plugs are then stored in stoneware crocks under tight cover.[1]

[1] Acid and alkali resisting paints and other metal protective coats fail to preserve the iron settling tanks, blunger tanks, pug mill, etc., from corrosion. It was found that an application of an alcoholic solution of copal seed gum to perfectly clean metallic surface gives a satisfactory and lasting coat. Asphalt coated wooden tanks would serve better.

Conditioning and Forming

The equipment employed for reducing the moisture content of the 2-inch plugs to that required for satisfactory press extrusion has been designed to obtain uniform moisture distribution. Wahl Eversharp leads are manufactured within diameter limits of variation of only .001 inch. The diameters of the leads would not come within this lim t if the moisture variation from time to time should cause the pressure gage on the hydraulic press to show a variation of $^1/_4$ ton on a ram of 20-square inch cross-section. In the production of leads dependence must be placed on the equipment and processes for assurance of being within dimensional limits, for piece inspection is not practical where the production per month is some 250,000 gross sticks of leads.

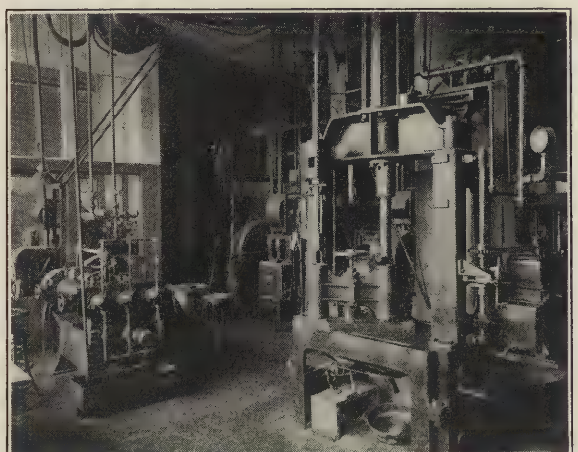


FIG. 3.

Figure 2[1] is a view down the aisle where the lead batches are dried and where the plastic lead coils are formed through diamond dies in hydraulic presses.

In the foreground are stoneware crocks in which plastic lead plugs are awaiting transfer to one of the four humidity drying cabinets just opposite the man in the aisle. The humidity cabinets are separately controlled with thermostats. The humidity driers for the heavy lead plugs are designed to have no circulation of air, whereas those for the formed leads have air circulation. Drying of the plugs is slower where there is so little air circulation but case hardening and excessive drying of the ragged parts of the plugs are thus avoided. The humid air fed into these cabinets leaves the cabinets only through the minute cracks at the doors, etc.

The man in the foreground is unloading a tray of plugs taken from the drying cabinet. They will be put through a small machine similar to a meat chopper. The material is reduced to pellets about $^1/_8$ inch x $^1/_2$ inch.

[1] The illustrations are from the lead plant of the Wahl Co., Chicago, which plant is equipped to manufacture 250,000 gross sticks per month of standard leads in black and colors.

A load of 250 to 300 pounds of pellets is placed into the revolving and tilting drier screen seen in the right foreground of Fig. 2. A fan shaped duct conducts humid air to this screen. A good circulation of air of low drying efficiency through the tumbling pellets causes them to dry very uniformly. Dust particles, which granulate off the ragged ends of the pellets, pass through the screen into a bin below. This avoids excessively dried small particles which would cause hard spots, spots of excessive diameter and points of weakness in the finished lead. The tilting arrangement permits the screen to empty itself.

The man standing at the first hydraulic press is tamping small pellets into one of the press cylinders.

The girl is testing the shrinkage by rapidly drying straightened lengths on an electric hot plate. A record of this is made and goes along with each lot of 25 gross of lead until all work on the lot is completed and it is ready for packing. This rapid drying does not give the true shrinkage. It is indicative of what the production shrinkage will be. This testing likewise affords a check on the wear or any change in size or shape of the diamond die piece.

The Presses

In Fig. 3 is a close-up of one of the lead presses, showing the control equipment. To the left is the tamping rod; at the center is the plunger which forces the lead through the die plate, holding, in the case of black lead, one diamond die. Below is a pan receiving the coil of lead and just above it a whirler device to direct the lead strand into a perfect coil. To the right, just above the base of the press, is a control lever, and just above it a worm gear attachment with which the finest adjustment of pressure and speed of coil forming is effected. On most of the presses the control is obtained with needle valves. The fine adjustment device shown here, however, is the better of the two controls.

FIG. 4.

Equipment and Method for Indelible Lead

To the rear in the center of Fig. 3 is a steam jacketed, phosphor bronze lined dough mixer, in which the indelible lead mixtures are worked up to a tough consistency. The indelible lead mixture is then transferred to the special three roll mill, shown in the left fore-

ground, to complete the drying to the point required for introduction of the material into the lead forming press. For colored and indelible leads the three roll machine, therefore, replaces the filter press.

The various colored lead mixtures also are conditioned and rendered uniform on rolls. These colored mixtures are prepared in small pebble and stone mills similar to those used in the paint industry, some of which will be seen in Fig. 4. The stone mill mixtures require preliminary drying before going to an agitating machine, known as a pony mixer, from which the semi-fluid mass goes to the large three roll machine.

In the foreground of Fig. 4 two operators are shown coiling indelible lead from a pan onto a rotating drum.

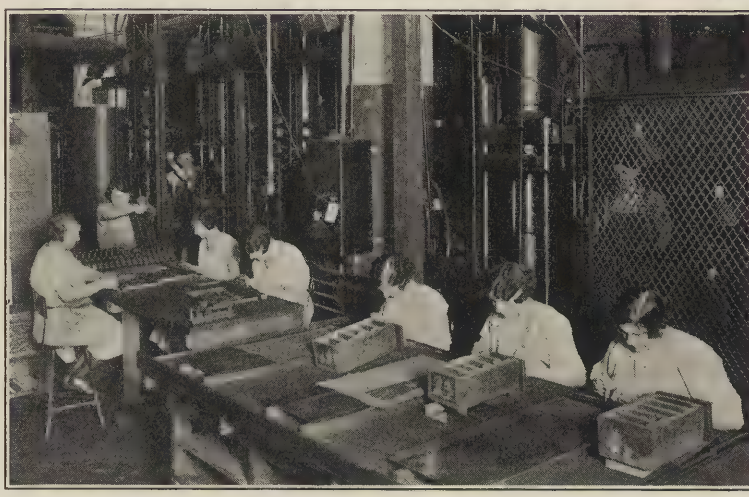


FIG. 5.

The second girl from the left in Fig. 5 is cutting the dried black leads at one end of the four special cutting machines employed for this work. Whereas indelible and colored leads are sawed, the black, unfired leads are cut by means of roller knives under spring tension and perfectly guided in grooved slots. The automatic machinery used for loading the finished leads, in order to operate, requires that the leads do not vary more than $^1/_{64}$ inch in length. The leads are taken from the humidity cabinets before they become bone-dry. This avoids excessive breakage and jagged ends that might result if they are too dry.

The three girls at the bench in the right foreground are rejecting short, broken and any other imperfect leads. The cut leads are placed in containers. A box load of five of these containers constitutes a crucible load for the furnace.

Firing After the leads have been transferred to clay-graphite crucibles boxes, and the covers sealed, they go to the furnace room, one corner of which is shown in Fig. 6. Each crucible box holds approximately 250 gross sticks of leads and eight of these boxes constitute a furnace load. The fired leads of one furnace load has a retail value of $3600, priced at 15c per dozen sticks of leads in the Red Top Eversharp lead boxes. An average of three firings per day are made, five days a week, throughout the year.

A battery of two furnaces is used, in the first one of which the leads are brought up from a temperature of approximately 200°F through a clay dehydration temperature of about 1200°F.

The eight crucibles are then transferred from this furnace to a second one where the firing is continued on up to temperatures from 1700° to 2100°F in accordance with the degree of lead being made. A shift from one furnace to the other is made to gain the advantage of saving furnace cooling time for the successive firings. This procedure also proves to be easier on the furnace linings and hearths.

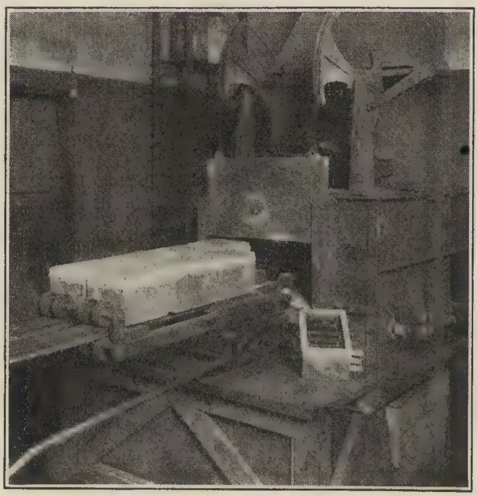


Fig. 6.

The furnaces were specially built. The hearths are carborundum specially designed with resting blocks on which the crucibles are placed. The feeding fork is operated on a turntable and mounted on a truck to facilitate the transfer of the furnace loads, as well as the removal of the hot crucibles from the furnace room to cooling chambers in the next room adjoining.

The outside surfaces of the crucible boxes are glazed, thereby increasing the life of them. The sealing material is a blend of suitable refractory clay and other ingredients to produce just sufficient porosity to permit the escape of the gas without the danger of oxidation of the graphite.

Graphite Ash Effect Firing Schedule Whereas pencil leads are composed of just two general classes of materials, clays and graphites, yet the blends of clays and the blends of graphites employed make standardizing of the firing process difficult due to the firing behavior of the ash material that is ever present in even the best of graphites.

Appreciable reduction in the percentages of ash in the graphite is pos-

sible by the well-known process of Walter E. Trent for purifying coal, etc., but it is perhaps impractical to expect more than about 50% elimination of the ash. Graphites for which the ash exhibits objectionable firing results had better be replaced by other graphite more suitable.

Knowledge of the initial temperature of vitrification and the temperature range of vitrification before overfiring is reached for this graphite ash is most important, particularly where the lead diameter is small. When vitrification of ash must be contended with firing temperatures employed generally are above that at which the ash vitrifies and overfires.

Leads of larger diameter which permit of higher percentages of clays can be fired to lower heats. For small diameter lead the lower temperature firing may result in ample strength but too harsh a quality, or satisfactory quality and insufficient strength. A guiding knowledge of firing behavior of graphite ashes is therefore important for blending graphites to obtain a uniform product.

Fig. 7.

The total ratio of the graphites to the clays for the various degrees of leads is dependent upon getting a satisfactory blend of the graphites. Materials which will make a most satisfactory lead of .076 inch and larger diameters will not necessarily do so for an .0465 inch diameter lead. A premature strength at a certain heat treatment results partially from the initial sintering of the clay but primarily to the earlier vitrification of the graphite ash. This early vitrification of graphite ash produces a harshness in lead with low strength that would be standard for the softer leads. To control within .001 inch variation in diameter requires a knowledge of variation in firing treatment of the graphite ash.

Testing and Inspection

In Fig. 7 is shown a section of the department where lead diameter measurements are made and cross breakage strength of the fired leads is tested. The fired leads are then soaked in wax mixtures. After solidification of the wax the cross breaking test is again made and a test made for writing quality. The writing quality test consists of writing a few

words, always using the same quality of paper. Diameter testing is made with Brown and Sharpe micrometers. Should rejection be necessary it would be found that either a crucible box has become defective or the thermocouple protection tube needs replacement or some of the control instruments are not operating perfectly. Control of the manufacturing processes rightly deserve the burden for errors. Control must be positive throughout the process if leads are to be profitably made to exact or close specifications.

Waxing and Polishing

The man in Fig. 7 is at the waxing cabinet where fifty gross units of the fired leads are soaked for a given time in a suitable wax mixture according with the degree of lead. After sufficient drip the leads are placed in the heated, rotating tumbler shown in the left foreground. Hardwood sawdust of definite fineness is tumbled with the leads to reabsorb the wax from the surfaces of the lead to prevent the leads from sticking together.

After sifting the leads from the sawdust they are placed into a second shaker where the leads are polished. A permanent polish could be made only by aging sufficiently for the maximum exudation of wax on the surface before subjecting the leads to a polishing treatment. The grayish color due to excess wax or lack of polishing has no important bearing on the quality or strength of the lead. Softer grades of leads will show this wax accumulation more than the harder grades.

The waxing treatment of colored leads is very much more difficult without changing strength and diameter of the colored leads. Waxing of these leads is primarily to coat them, making them less absorbent to moisture. Practically all makes of colored and indelible leads will soften and swell materially under certain conditions of temperature and humidity, such as in a man's pocket during the warmer months of the year.

THE WAHL CO.
CHICAGO, ILL.

NOTE ON AN UNUSUAL CASE OF WARPING OF FLAT WARE IN THE GLOST KILN

BY THOMAS A. SHEGOG

This case occurred purely by accident. It became necessary to use a different glaze for decoration considerations from the ordinary type of glaze in regular use.

So I tried out a glaze which was given several years ago by a very well known English ceramist in which, instead of feldspar, we used Cornwall stone and instead of boric acid we used borax.

The composition of the glaze was this:

Frit		Mill	
Borax	23.5	Frit	40.25
Whiting	18.5	Flint	10.50
Flint	30.5	Cornwall Stone	28.75
Soda Ash	12.75	White Lead	21.00
China Clay	14.75		
	100.00		100.50

That is the composition of the frit, which I only write down for the purpose of showing that in addition to borax and no boric acid, we introduced soda in the form of soda ash. I do not know why, but you will see the effect that produces in the molecular formula.

The molecular formula for that glaze is:

$$\left.\begin{array}{l} 0.262\ PbO \\ 0.340\ Na_2O \\ 0.051\ K_2O \\ 0.346\ CaO \end{array}\right\}\ 0.280\ Al_2O_3\ \left\{\begin{array}{l} 2.822\ SiO_2 \\ 0.230\ B_2O_3 \end{array}\right.$$

The alumina is almost exactly one-tenth of the silica and the oxygen ratio is 3.44/1.

Perhaps the most striking difference between it and the usual glaze is the very abnormally high content of soda and the correspondingly low content of potash.

We took some ordinary seven-inch plates from stock and after dipping in this glaze we fired them in the glost kiln in three saggers, 5, 8 and 13 high, respectively. These saggers were fired in the second ring, which is our usual practice.

I should say that the absorption of the biscuit ware varied from 7.5% to 9%.

These were placed with one stack in each of the saggers, and a second stack in each case with similar ware was dipped in the regular glaze. But when the kiln was drawn, I was amazed to find that in every single case the plates were twisted in the most extraordinary fashion.

The peculiarity about it is that the second stack dipped in the ordinary glaze and fired in the same saggers was perfectly straight, and so also was the ware through the rest of the kiln.

To confirm that, I took another series of plates and repeated. Conditions were exactly the same; but in this case the glaze was matured a little better; the fire was a little higher. The plates were very much straighter although they were still warped.

On the very crooked ones the glaze was by no means matured. In the second series they were still underfired but more matured than the first.

It must be that the warping was due to the glaze, since it was the only variable, and I was at a loss to explain the action to myself. The only explanation that I could find for this was as follows:

At the time the body is in the glost kiln the body softens slightly and when the kiln begins to cool, if the glaze solidifies before the body has become entirely rigid, the contraction of the glaze might be sufficient to pull the still soft body out of shape.

This explanation is not convincing; it does not entirely convince me. I have spoken of the occurrence to a great many ceramic friends but none could even suggest an explanation or had ever seen anything of the sort before, so for that reason, I brought it before the SOCIETY in the hope that some of the members may have had similar previous experience or may be able to suggest a better explanation than my own.

There is just one other point I would like to mention. If my explanation is correct as to the cause of the warping it would seem probable that the glaze (on the first series especially) would be in a state of high tension, and therefore very liable to craze, especially as it is immature. But that is not the case at all. That glaze has not crazed after heatings to 200°C, with intermediate dippings in water at 15°. That seems to knock my idea.

In the second series of experiments, although the glaze is better matured and there is less warping, the ware is much more liable to craze, and invariably the piece is crazed on the second dip.

I leave it now in the hands of the members, and I shall be very glad indeed if anybody can suggest an explanation of this thing which has puzzled me for a long while.

SEBRING, OHIO

Discussion

E. SCHRAMM: Mr. Riddle, did you not do some work showing the effect of the glaze on tensile strength?

F. H. RIDDLE: That was making small tensile test pieces and glazing them with different types of glaze and determining the strength. With a glaze that fits the body the strength is materially increased while with a poor fitting glaze the piece would show a much lower tensile strength than the specimen with no glaze on it whatever, indicating that in small pieces the fit of the glaze is very important, also making a very nice method of determining which glaze really fits the body best. That, though, does not explain the drawing or pulling that the glaze must be doing in Mr. Shegog's case.

A. S. WATTS: It may just be a coincidence, but in the plates that have passed through my hands in the last few minutes, I observed that the warped plates all are distinctly yellow. Now I can only interpret that in one way, so far as my observation of this problem goes, and that is that the warped plates in the bisque were not fired as hard as the straight plates. Did you make any determinations to know what their porosity was?

T. A. SHEGOG: They are all between $7^1/_2$ and 9% absorption.

A. S. WATTS: If the yellow plates were more porous warping might occur from the soluble salts in the body, absorbed from the frit. I think it is worthy of very distinct consideration that all of these plates that are straight are much whiter than the plates that are warped.

T. A. SHEGOG: I think that must be purely accidental. The plates used for both series of tests were taken at random from stock and the glaze was the same batch; all were dipped in the regular way.

A. S. WATTS: I am not offering this as a solution—it is merely an observation. Why are the straight plates white and the crooked plates cream? I have seen instances where the presence of a certain amount of soluble salts in a body developed distinct warping when they came to the last stage of firing, and I merely make that as a suggestion which may throw some light on the problem.

S. RUSOFF: With reference to the tensile strength, some few years ago we had considerable warpage and in making an absorption test of some of the glazed tile, the same sized tile, I noticed quite a difference in the absorption between the straight tile and the warped tile. With this thought in mind, a set of trials were made using the same dust but giving a portion more pressure. Firing the trials at the same heat we found a considerable difference in the warpage of the tile. The more compact the body the less warpage we had to contend with.

CLAY STORAGE[1]

BY ROY A. HORNING

Advantage, construction, equipment and operation of clay storage for brick plants are related.

Clay storage is a worth while consideration by any one interested in the manufacture of heavy clay products. The trouble has always been that most heavy clay products such as brick and tile can be made without it. However, it seems to me that more and more this subject is finding its way to the attention of the progressive manufacturer and if the benefits to be derived from it are fully understood there will be more storage facilities built.

Perhaps the best recommendation for the clay storage is the man who operates one that is properly designed. However, there are many who do not have one and are not familiar with its advantage. The advantages of a clay storage can be divided into two classes, the two overlapping to a certain degree. (1) Complete unification of clay digging and preparation. (2) More uniform mixing of the clay.

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Columbus, Ohio, Feb., 1925. (Heavy Clay Products Division.)

(1) What does complete unification of clay digging and preparation mean? It means operating your clay digging and preparation as a separate and distinct unit. How many employ power shovels? How many see every day a shovel capable of digging two times, three, or even four times the amount of clay that the plant actually uses? The clay storage makes it possible to utilize this extra capacity to a better efficiency. If it is possible to dig sufficient clay in four hours to operate ten, why not do it?

This allows that particular unit more flexibility in operation as well as many outstanding economies in labor and overhead. How often have you seen a steam shovel, four or five men, a locomotive, in fact the entire clay digging equipment stand idle for an hour waiting for some one to make a minor repair in the mill? Likewise, how many times have you seen twenty-five men waiting for clay to come from the clay pit? Now would it not be better to have a clay storage in between these operations? That is where a direct economic saving can be effected. The wages of one or two men operating a clay storage will more than be offset by even a few hours loss of production.

Have you ever seen days during the winter when you yourself would not think of wanting to be out; yet you must have the pit crew out if you want to make brick on these days. Humanity has some rights even in a clay plant and this phase should be given consideration. It is possible with a clay storage of proper design to choose to a certain extent the days on which you dig clay. This not only proves a saving in the cost but also may save many a delay due to wet, frozen or icy clay. I visited a clay plant last year whose capacity was 100,000 per day. I visited them during a rainy period of a few days; their production had dropped to less than 40,000 per day. The feeders would not feed their clay in such a wet condition. A clay storage would have been a life saver for this plant. One-half mile away another plant was working, making 110,000 per day, had a clay storage and made their capacity each day. In one case the clay pit men were sliding and slipping around the pit trying to get a little clay dug, in the other case the pit crew was repairing their equipment. Which of these two was the gainer?

There is always much work to be done as an accessory to the actual digging of clay such as stripping, shooting, moving track, etc. How many plants employ a separate crew of men for this work, where if the full capacity of their digging equipment was utilized, enough time would be left to take care fully of a great portion of this extra work. I do not say that in every case clay pits are run inefficiently. I only know what I have seen and I might say I have seen very few which were efficient even up to 50%.

Some plants find it necessary to operate with a mixture of two kinds of clay and in order to do this have two complete crews of clay pit men, one

for each pit. This often can be reduced to one crew by using them at one pit one-half day then moving them to the other for the rest of the day, putting the clay in the storage; and by proper distribution it can be mixed even better.

(2) The advantages pointed out so far are purely economic. Nothing has been said about the improvement of the ware. Quality of finished ware begins at the clay pit. Rarely if ever will a clay pit run uniform from the top to bottom, or from end to end. The variation may even be so great that two successive hours running will not produce the same clay. However, if an average of a day, week or month could be taken, it would be found that a composite sample of the clay would be about the same from day to day. Thus, by using a suitable storage, the clay could be so mixed that a very uniform run could be secured.

Much of the trouble in heavy clay products can be traced back to the variation in the clay from hour to hour or day to day. Clay dug and rehandled through a storage seems to act entirely different from clay dug directly from the pit. This is due to several reasons. The moisture content of the different strata of clay becomes uniform. There are small lumps of dry material and some very moist. When these are put into storage the clay with the most moisture will yield to the absorption of the less moist and in addition to this there is much evaporation. The fact that the clay lays for some time ages it to a certain extent, apparently making it work more uniformly when used.

By proper distribution of the clay in the storage shed any desired mixture can be obtained. This question of distribution should be carefully guarded as it is very easy to put clay into storage and take it out exactly as it was put in, effecting very little mixing if any.

What value can be placed in the storage shed as a mixing proposition? This depends entirely on the character of the clay put into it, also the preliminary preparation that has been put on the clay. Clay should have some preparation before going into the storage shed. It should never be stored, in my estimation, as it comes from the bank. Clay coming from a bank as a rule will have a great many large lumps in it. These lumps should be reduced to a small size since there is a tendency for lumps to separate from smaller material when dumped into a pile. Better yet, all the clay going into storage should be prepared for its final use if possible to do so. That operation being done the grinding unit can work independent of the manufacturing units. Sometimes it is advisable to have the storage divided into two divisions: one to care for a reasonable amount of freshly dug clay, then after grinding to its proper size, another larger storage for ground material. This may prove to be a decided advantage in some cases, and especially is this true where fine grinding is required. It may be an economical arrangement to run the coarse grinding plant along

with the digging, setting up a fine grinding unit to run 24 hours per day. There is much room for improvement in the matter of digging, handling, preparing and storing of clay. Many economies may be effected and many improvements may be made in the qualities of the finished product before any real manufacturing is begun.

Types of Clay Storage

Plant requirements should be studied with utmost care and a storage built that will meet conditions of each particular plant. Its design depends, first, upon the nature of the clay, second, on the amount of storage needed, and third, the conditions in which the clay is to be stored; clay storage systems can be made to cost whatever you desire above a minimum amount. Just how many refinements you care to put in them regulates largely what they cost. I have seen storage piles entirely exposed, clay being piled up by cranes and being removed by steam shovels. I have seen them piled by cars and removed by cars, piled by belts and removed by cars, and vice versa. However, the most successful ones use belt conveyors to put it in and belts to take it out. Conveying equipment costs

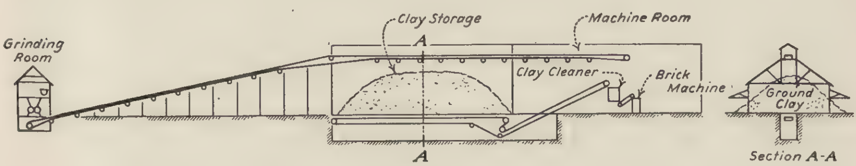


Fig. 1.

money and much money can be spent or saved by properly designed clay conveying equipment.

For instance, a conveyor designed to handle large lumps of clay will require a wider and heavier belt than one designed to carry ground material. A 24-inch belt costs $33^1/_3$% more than an 18-inch belt, and an 18-inch belt costs 50% more than a 12-inch belt, etc. Not only do the belts cost more but wide equipment costs more than narrow. This phase should be thoroughly studied to determine the most economical size and speed.

Last year we built and equipped a clay storage system that I am going to describe briefly. This system stores ground clay ready for use and consists of an overhead 18-inch belt running on a steel slide. Running in an opposite direction is a moving scraper, which acts as a distributer. The height of this belt is 30 feet above the bottom of the storage; it passes through the middle of an open-sided shed 60 feet wide. This allows us to pile clay 25 feet high. Allowing the clay to run to its natural angle of rest makes a pile 60 feet wide. The speed of this moving scraper is ar-

ranged so that it will pass over the entire range of the pile for each car load of clay. As an example, you want to distribute the clay over 100 feet. A car load of clay requires 4 minutes to grind, then your scraper should pass over the full 100 feet in 4 minutes or travel at a rate of 25 feet per minute. That means that each car will be distributed over the full length of the pile. The power required to pull this scraper at that speed is very little. It may be run directly off the conveyor belt or driven independently by a motor.

Through the center of this building below floor level is another conveyor running on steel plates; this conveyor is covered by means of a wooden plank about 12 inches long and 8 inches wide. As the clay is worked out the planks are removed and the clay dragged in by a hoe. This gives a cut through the pile which at an angle of 45° on each side of the center leaves the side stand. This makes available a section of about 312 square feet or about 312 cubic feet of clay per foot of shed. If trimming is needed it is very simple to run the sides in by means of a portable conveyor.

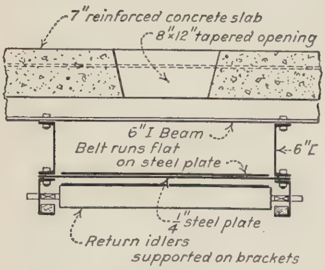


FIG. 2.

The conveyor for moving the clay is a 24-inch belt running on steel plates. This makes a dirt proof conveyor. No clay can spill into the pit below the pile. The return idlers can be bolted in the bottom of the steel trough which makes a very neat and clean conveyor pit. The cover for the conveyor pit is a 7-inch reinforced concrete floor and the conveyor trough is bolted to this floor thereby doing away with all posts or frame work for the conveyor.

This particular storage shed cost with conveyor complete is $4500.00 and will hold enough of clay to make 1,000,000 bricks. One man will remove sufficient clay if it is ground for 8500 bricks per hour. This storage was put in with the clay grinding plant behind it so that we are really storing the clay and taking it out with no extra men as by moving the grinding units we saved one man. This particular system might not be adaptable for another plant. Before building a storage the whole proposition should be surveyed to find out what is most practical. The system just described might be termed the open shed system where the clay forms its own retaining walls.

A much nicer but more expensive system can be built using concrete retaining walls and sloping floors whereby all the material can be reclaimed. However, as I have stated, each individual problem should be taken up and solved to meet the individual needs.

In the system just described the overhead belt runs over the clay shed and continues on to the pug mill so that at any time the clay can be passed

right on to the machines and not go through the storage. An elevator at the reclaiming belt elevates the material back on to the overhead belt going to the pug mill. The cost of operating this shed as far as labor is concerned is no more than our former system. However, the charges on the equipment run up an item of expense which as near as we can tell amounts to about 15c per thousand. This cost would depend a great deal on the production. In our case it is based on 10,000,000 per annum. However, when the saving in production and quality is calculated, a clay storage can easily pay its own way in every respect along with a dividend on the investment.

We desired to allow our clay to dry to a certain extent. That is really why we built an open-sided shed as shown. Being open with steep roofs the circulation of air is very rapid giving a great deal of drying effect. This is perhaps as cheap a shed as can be built as there is very little to it but a roof.

One should bear in mind that no wood should be used where it will be in the clay, for sooner or later it will rot. The shed that I have just described has no wood below the roof trusses; it is all steel and concrete.

The object of this paper has not been to give any unique system of clay storage but rather to bring a little more thought about its use and advantages that we may make better ware. I have tried to bear in mind that I am not recommending any particular type of storage as that should be designed for each individual plant to meet its own peculiar needs.

LANCASTER BRICK CO.
LANCASTER, PA.

PLANT MANAGEMENT METHODS[1]

BY O. J. WHITTEMORE

Statement of the Problem

Methods used in the management of heavy clay products manufacturing plants must necessarily vary with the circumstances and conditions peculiar to each individual plant. As it would be impossible to discuss different methods of handling similar operations all the way through the complete process, I will discuss principally those methods which at present are most familiar to myself; those which I have developed and used in the management of the two plants of the Sheffield Brick & Tile Company, located at Sheffield, Iowa.

In the past several years, the business depression in our territory, Iowa, Minnesota, Nebraska and South Dakota, has affected our business enough so that one plant's production is sufficient to take care of the needs of the trade. This condition has made plant operation more difficult, as

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, February, 1925, Columbus, Ohio. (Heavy Clay Products Division.)

all of our many varieties of shapes and sizes must be made at one plant and on one machine, where otherwise, one class of shapes could be made at one, and the other class at the other plant. The difficulties from this forced manner of operation are obvious. My paper will cover more particularly the subject of maintenance of production in one plant producing a wide variety of wares.

We manufacture all the sizes of drain tile from 4 to 12 inches, inclusive, common brick, smooth and matt-faced face brick, common building blocks, matt-faced and plain load-bearing blocks, the accompanying items of jamb, corner and sectional blocks, partition and floor blocks from 3 to 12 inches in width and furring blocks.

The difficulties incident to plant operation with these conditions are divisible into two classes, namely, those affecting the men, and those affecting the equipment. Changing of the men from one ware to another slows up their efficiency at the time of change. The changes necessitate many additional dies, cutters, machine heads, spacers, texturing machines and pallets, and these cause much loss of time and effort, as well as large investment. The bulk of clay to be dried varies with the different shapes, and different humidites and temperatures must be used. Differing procedures of setting and firing must be used at the kilns, and several methods of emptying with the different wares.

The problem of maintenance of high production is somewhat similar to that of a heavy freight train, after slowing up for station stops, momentum is lost and much additional power must be used to regain top speed. In this clay plant, the practice has been developed so all of the men help, in the transitory periods, to pick up the lost speed.

Piece Rates and Bonus

To get full measure of coöperation from the men it is necessary to provide for their wages and their morale. Their wages are established on a piece-rate basis, as much as is possible; the wheelers are paid per ton, or thousand of brick, the rates differing with the different wares; the setters per car of ware, the rate again varying with the kind of ware. The coal is unloaded and placed at the kilns for so much per ton. The kiln cleaning, casing, repair and sanding is contracted for a flat sum. The men connected in the machinery rooms and those in the pit, machine tower, drier and the transfer men are paid on a flat hourly scale, with tonnage bonus at the end of each month. The kiln firemen are paid on an hourly basis, on a merit system.

In addition, all men receive a bonus on the first of December for continued satisfactory service throughout the preceding year. This is dependent upon their remaining steadily with the company. This cuts down the usually high clay plant labor turnover. This bonus is figured

at so many cents per ton, thousand of brick, car of ware, or ton of coal handled by wheelers, coal handlers, or setters, as the case may be.

Besides all these forms of remuneration, we usually present each man with some sort of remembrance at the Christmas holiday season, and this year, we took out group insurance, a policy for each man in the company's employ. These policies are increased in amount with additional length of employment so besides having the effect of Christmas remembrances, they also are the yearly bonus for continued service.

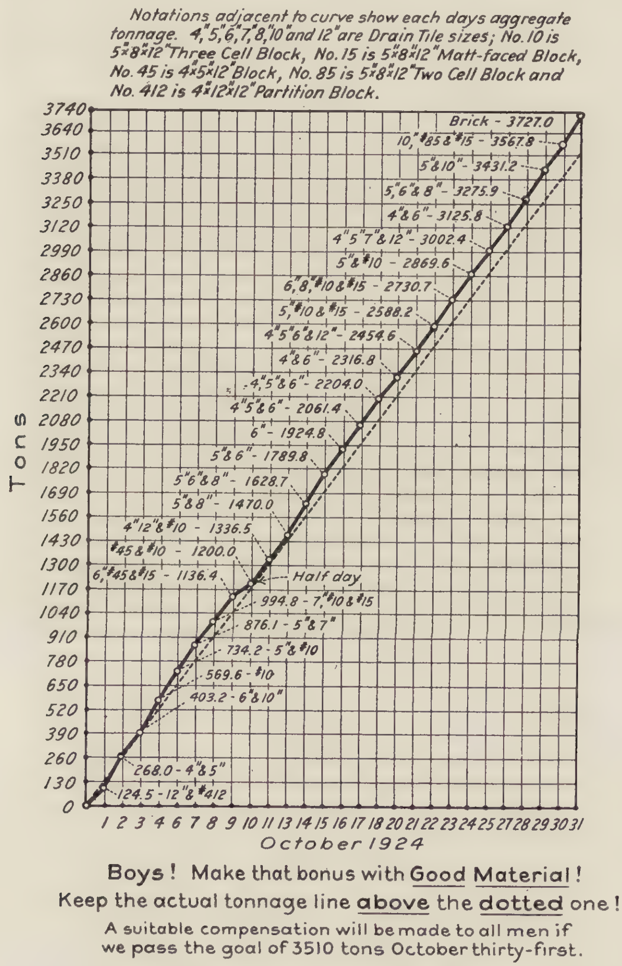


FIG. 1.—Production record, Oct., 1924.

Maintenance of Morale by Charts

For the maintenance of morale, a bulletin board is used. Charts are used to picture the progress of manufacture, setting a goal of monthly

production, and showing the actual accomplishment from day to day in a line of one color as against the desired tonnage in a line of another color. This is shown in Fig. 1, the dotted line showing the progress as desired and the black line, the actual attained tonnage, added day by day to the total previous tonnages. The establishment of this goal, and the attempt at attainment, makes an element of interest to offset the monotony of the never-ending repetition of tasks, and arouses their sporting blood, the great American love of contest.

We have several forms of charts, the monthly chart, already described, the daily chart and that for the whole year. On the daily chart an ex-

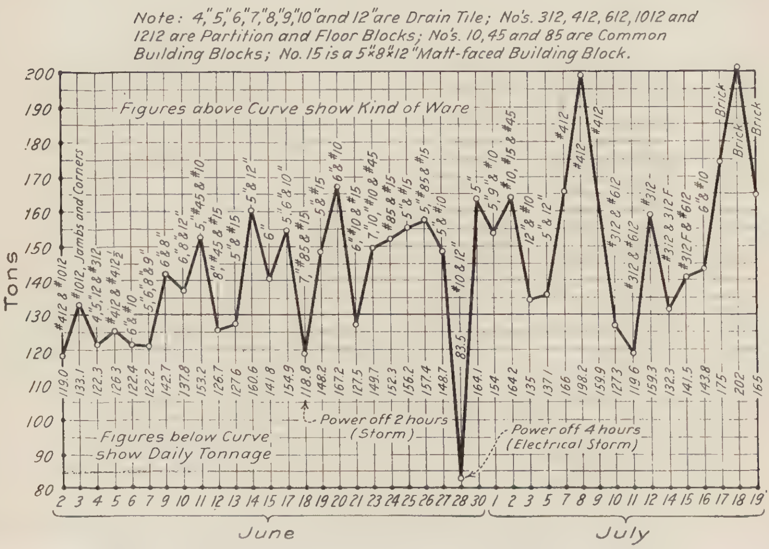


FIG. 2.—This chart shows each day's production separately.

ample of which is shown in Fig. 2, the daily results are shown separately, there being a horizontal line, picturing an average tonnage, and the accomplished tonnages forming a series of ups and downs, accentuating the low and high attainments. On this sheet, we make notations to show the men if the results, whether good or bad, are directly traceable to any particular department or individual, or due to the limitations imposed by the particular type of ware. On the illustrations are noted the kinds of ware made each day, but this is not shown on the actual charts.

The charts and notations arouse the men's interests, start them to thinking where they can help, stop much of the grumbling and discontent, and give them something to talk about, in connection with their work. The results in greater tonnages of good ware are well worth the extra effort.

Special bulletins are posted calling the attention of all the men to the

need, if results show that one department is lagging. These bulletins are in addition to instructions made directly to the department heads. Compliments as well as corrections are noted on the bulletin board, so that none may think we are continually nagging, with no appreciation of their efforts. These bulletins are supplemented by frequent group conferences of the department heads. At these meetings, past performances and future procedures are discussed, and the departmental efficiencies are brought to light so mistakes can be corrected and improvements made.

A complete plant cost system is kept and at the end of the month, a summary of costs, production and shipping records is made. Some of these results are disclosed at these group conferences. Discussion of the relation of production to costs, emphasizing the large increases in costs as they accompany shrinkages in production, whether daily, weekly or monthly, has been very beneficial to the foremen but we would not consider it wise to discuss these things with all of the employees.

Attainment of a charted production goal is rewarded in various ways. Most of the men who are not working on a piece rate basis are given in addition so many cents per ton production in excess of the established goal. This is a definite reward, offered every month, but in addition to this, we have given them special prizes, such as dinners, picnics, entertainments and movies, all of which tend to maintain interest, on account of the novelty of the ideas.

Description of the Plant

Gathering the Clay The common pit for both plants has a face of 34 feet of Devonian shale. This is gathered by a shale planer, supplemented by a steam shovel for cleaning up the wedges of clay left by the planer. The planer can be operated so that it will clean up for itself, but it is not economic, since it necessitates more frequent moving of the planer, and less efficient cutting duty.

A large, deep drainage system around the pit cuts off the seepage water which in the spring formerly caused cave-ins, and in the winter caused the bank to freeze harder with accompanying bulges, all of which made the planer duty much more severe, with many mechanical break-downs, higher maintenance cost and smaller production.

Clay Preparation and Manufacturing The clay is hauled from the planer by a drum and cable hoist to a central station, where cars can be dumped into hoppers which empty into other cars going to either of the two plants. In the plant, the clay dumps into a hopper, from whence it is worked out through a granulator or heavy pugmill. Since the advent of the planer, the granulator's duty is much easier as the clay comes to it in much smaller pieces. Water, hot in the winter time, is introduced at this point, and then the clay runs through a

set of conical rolls, which remove the small quantity of soft sand rock, and also do all the grinding necessary for the soft shale. The clay next goes through two separate pug mills. It then goes into an auger or stiff mud machine, through dies, to automatic cutting tables, thence to the off-bearing belt, and from there is placed on double deck drier cars.

This machinery is housed in a five-story fireproof building of brick, steel and concrete. The clay movement is entirely by gravity, thus eliminating troublesome elevators and conveyors.

The plants are electrically driven, the "juice" purchased from a high-line company, on a sliding-scale rate. A large motor is used to drive the line shaft from which drives are belted to the granulator, rolls, pug mills and auger machine. Individual drive is used elsewhere. The line shaft runs in ball bearings as also do two of the larger motors. Three of the larger drives are chains, and the rest are belts.

Drying Drying is done in twenty-four-track waste heat driers, with fans at both ends. For heat additional to that furnished from the cooling kilns, an auxiliary furnace has just been added at one plant. These driers hold approximately 400 cars apiece, and have stub track space at both ends so that the driers can be worked 24 hours of the day.

Firing There are at one plant 12 round down-draft kilns, 30 feet in diameter, steel-shelled, with triple draft bottoms, and checker work floor; and 16 kilns, 9 of which are 26 feet in diameter, and 7 are 30 feet in diameter and steel-shelled, at the other plant. At the newer plant, the 12 steel-shelled kilns have only the one 150-foot smokestack, while at the other there is one 65-foot stack for every four kilns. The one large stack is considered to be an improvement, as there is always sufficient draft, even for water-smoking, and there is no tendency for one kiln to rob another of its draft.

Placing the kilns in one row with a single stack, necessitates the use of an electric transfer car to take the ware speedily from the drier to the setters at the kilns.

Scheduling of Plant Flow

Much planning and careful supervision must be given to produce quantity and quality. It must be continually emphasized that the operation of machinery must be punctual and continuous; that small delays be eliminated, for they total into large leaks. Schedules for manufacture of ware of particular groups are established and followed as much as is possible. Occasionally with large rush orders, balanced stocks will be affected so that changes in plans have to be made.

It is better practice to make nothing but one class of ware during a certain period, and these periods should preferably be long. Large shapes are

preferably made when large shapes are being set and fired as the plant rhythm is thus better maintained throughout. Long runs of brick are most productive but in case of shortages in stock, by operating on brick on Friday and Saturday, the extra day, Sunday, when the drier is not worked is sufficient to give the extra drying the brick require. Changes of machinery, etc., can be thus made on Sunday.

When slower drying and setting ware is being placed in the kilns, slower machining stuff is made, thus keeping a better balance between setters, drier and machine. Schedules are made so as to permit the changing of dies, heads and cutters, at the noon hour, in the evening or on Sunday. An exception is made to this rule with most sizes of drain tile, as these dies can be changed in ten or fifteen minutes. Wherever possible, the schedule is arranged so that the heavier wares will be going through the drier when heat is available for the drier from kilns containing heavy wares. The more tender wares, which are more difficult to dry are scheduled for manufacture when the drier is foreseen to be in better shape to handle them. The heat and humidity conditions of the drier must be manipulated to correspond to the particular ware to be dried. Often the tender drying wares are made on Saturday, or on a day before a holiday, so that their movement through the drier will be postponed a day and thus allow for the needed slower humidity drying.

Drying Control A recording thermometer shows the temperature in the main inlet tunnel to the drier. This is supplemented occasionally by use of a hygrometer to check humidity conditions in the cooler end of the drier and to set the exhaust dampers to balance the exhaust from the individual tracks. There are various other controls on the drier, such as a relief stack at the hot end to cut down the temperature when excessive, and still be able to cool hot kilns where shipping needs require the prompt emptying of these kilns in the summer time.

Where the temperature is too low, the auxiliary furnace is pressed into service. Where higher humidities are required for certain wares, a slackening of exhaust is effected by opening additional air ports to the exhaust fan, reducing exhaust damper openings, or, in drastic conditions, by shutting down the exhaust fan entirely. This is not desirable for some wares on account of the danger of scumming if the exhaust is cut off too long. The stub tracks allow the 24-hour operation of the drier, and this increases the drier output and cools the hot ware in time for the setters each morning in the summer time.

Firing Control An Indiana fifth vein nut coal, $1^1/_2$ by $2^1/_4$ inches, shipped on a steam coal freight rate is used in the kilns. It is a long flame, gassy coal, with medium fluxing clinker. The kilns are pyrometrically equipped; an indicating instrument being avail-

able to the burners, and a recorder in the office. Most of the ware is fired with reducing conditions throughout the main part of the firing. Some wares, where a light clear color is desired, are fired with as much oxidizing atmosphere as is possible with slant grate fireboxes. The finishing temperature is approximately 1800°F. The firing records show the average firing time, including watersmoking, to be 48 hours with an average coal consumption of 390 pounds of coal per ton of ware.

Close attention is given to the cleaning of the bottom of the kilns, and with this done, uniformly fired ware from top to bottom, over the whole cross-section of the kiln, is accomplished in our steel-shelled, triple draft bottom kilns. Dirty bottoms are the cause of loss in many ways: greater fuel consumption, slower kiln turnover and poorly fired ware, which must either be waste or sold at a loss.

Slugging of fires, with greater firing intervals, as the average fireman will operate, is another source of loss, as kilns will progress slower, have higher losses of poor ware and cause higher coal consumption. To offset these and other tendencies on the part of the firemen, various bonus schemes have been worked out, whereby crews of firemen are given merits for lower coal consumptions and higher than average percentages of No. 1 ware, while demerits are given for the opposite results. At the end of the month, these merits or demerits are balanced and the firemen's pay checks increased or decreased accordingly.

A separate bulletin board is kept for the firemen, and on this, a daily record of demerits or merits is kept for all kilns as fired off and emptied. A rivalry is set up between crews to get the higher record and comments are made on the bulletin board to agitate this rivalry. At first, there was a tendency for crews to present alibis for poor results, such as kilns being dirty, different coals being given them, or different setting of ware, but by being sure that kilns were kept clean, using a uniform grade of coal, preserving uniform conditions as much as possible and maintaining an uncompromising attitude, the crews soon worked into the idea and better results were soon forthcoming. Kilns come off regularly and the whole plant operates more like clockwork as a result.

Control of Quality

Much emphasis has been given so far to quantity production, but quality is not overlooked. A very careful watch is given this as well. There never was a time when clay products manufacturers were competing any more bitterly for business in this territory. All manufacturers are trying harder than ever to make extra good ware. Customers are expecting better material and object very quickly to any let-down in quality. The men all throughout the plant are constantly cautioned to maintain the superior quality of Sheffield Clay Products. They are shown

where they have their individual responsibilities in this accomplishment. The pit men are coached to keep out impurities such as large rock, roots, weeds, etc., the machine men to keep the rolls grinding fine and steady mixtures in the pug mills. The dies are watched closely so that no change will occur in the positions of cores, etc., thus causing differential flow of clay and the accompanying reduction of quality and increase of imperfect ware which must be rehandled. The off-bearers have their machine room foreman watching them constantly, and they are trained to handle the ware carefully, reject and throw back into the waste conveyor all cracked, bruised and deformed pieces. They are constantly given to understand that they are responsible for the right start in life of all the material and that they must not be careless.

The transfer men, drier man and setters are likewise shown where they can assist. The firemen profit when they make better ware, as was previously described. The wheelers are continually warned against excessive rush, rough handling and poor sorting. When complaints come from customers as to quality of ware received, and especially as to excessive breakage where it has not been shown to have been railroad negligence, a conference is called of all of the loaders and such communications, as well as the complimentary letters, are read to them so they can get the viewpoint of the company and the customer requirements. In furtherance of this same idea, occasionally when complaints come in, the loading foreman or superintendent goes to the point in question, and gets a close-up of the situation; tries to determine in his own mind whether or not the complaint is justified and makes adjustment when necessary. On his return to the plant he calls a meeting of the department heads if it is a point needing the attention of all, or otherwise a group of just those particularly concerned in the need for improvement or change in methods.

No one system or plan of plant operation will fit all plants. Circumstances will alter the methods, but generally speaking, the principles of operation which we endeavor to follow can be used everywhere. In the handling of men, if the policy is one of fair play and justice to all, if the pay is reasonable and interest is awakened in their work through contests and schemes of various sorts, you are bound to have a satisfied loyal crew that will coöperate to their limit to produce both quantity and quality. Augmenting this policy toward the men, if the equipment and machinery is handled through scheduled and thoughtful operation, planned to eliminate delays and to get the maximum results for the effort extended, your clay plant manufacturing troubles will soon cease to be erratic and resolve themselves into a smooth, clock-like precision that makes for the elimination of the term "game," as applied so long to our industry, and puts it on the higher plane as a real bona fide business.

Sheffield Brick and Tile Co.
Sheffield, Iowa

DRYING, DRIERS: THEIR OPERATION AND CONTROL

By M. W. Blair

Introduction

A road often traveled is seldom familiar. A tree, a house, a sharp turn suddenly comes to our notice and we wonder if it has been there all the years we have passed that way day after day. So it is in the manufacture of heavy clay products. We follow the same road for years, then our attention is called to some oversight, some lost motion in the process, or an obviously ridiculous method, and we wonder if it has been there all the time. Usually it has but often it has crept upon as unaware through neglect, habit or ignorance.

This tendency to pass by without seeing is one reason for repetitions in our programs and discussions. Everybody does not wake up the first time the alarm is sounded or the loss pointed out. With the passing years there is constantly a new crop of foremen, superintendents and engineers and to them the past experience of many is a new adventure and the problems new.

The property of air to carry moisture and the power to absorb it from moist bodies, is the basis of drying of clay ware. The ability to obtain the most drying power at the least cost is the problem of the designing and operating engineer. The problem seems simple to the uninitiated but in practice, it is complicated, wasteful and one of the least understood. Internal strains, causing ware to check, crack, blister, twist and warp and scum producing gases are some of the problems connected with drying.

It is not the purpose of this paper to cover all of these problems but to bring attention to a few causes of failures in the operation of driers and to suggest methods for increasing quantity and quality production and for lowering of cost. Our big problem now is not to design a new drier but to get the most out of the driers we have and to make them earn money.

Drier Faults

Most of our driers are designed to be progressively operated, *i. e.*, of the tunnel type, admitting green ware at one end and removing it dry from the other. Few driers of this type are working in a satisfactory manner. Capacities, in most cases, have been over-estimated and the plants are few that do not set toward the end of the week some wet ware.

One mistake of operation is the attempt to crowd into a period of six or seven hours what was intended to be accomplished in twenty-four hours. Ware which has been in the drier a period of thirty-six hours has not necessarily received a proper drying treatment. A car of brick made at 7 A.M. is often the fourth car from the door by 2 P.M. Under such conditions, it has received mighty rough treatment in the early stages and has

then been over-dried for hours before being drawn. Those cars drawn later are often over-dried on the top deck but still steaming on the bottom courses because the setting crew is permitted to finish its day around 2 P.M. The entire day's output is through the drier by that time. In many plants the day's run is also finished and the drier is put to sleep for the night, a long night too, for it stands idle sixteen hours out of the twenty-four.

The first four cars which are over the heat have finished drying in the course of four to six hours but the heated air from fan or furnace continues to pour through the already dry ware. The humidity of the air then drops, its temperature rises, its velocity increases, and away go the heat units over the top to the stack and out.

Advantage of Continuous Operation

All sorts of devices have been introduced to overcome this difficulty, bottom draft at wet end, either to stack or fan, curtains, deflectors, pressure and recirculation. Verily, laziness is the mother of invention but the wind, even in a tunnel drier "bloweth where it listeth and no man knoweth whence it comes or whither it goeth."

The common-sense cure is to draw and charge the drier over the entire twenty-four hour period. This can be done by working the setting crew in shifts and providing empty car storage. Continuous operation hastens the kiln turnover. The ware being uniformly dry, not red hot and bone dry in one spot and little better than mud in another, reduces the drier loss, lessens scumming, kiln marking and production of bats. It also shortens water-smoking periods and increases the percentage of No. 1 ware and the kiln output.

This suggestion applies to any progressive type drier. It will apparently increase the cost of drier operation but it will decrease the cost of ware per ton because of better quality and increased production. The machine crew will have a supply of empties. The setters will be able to take more time and consequently more care and can work more efficiently. The closing of a kiln will not be the cause of loss in output due to slow setting

Temperature Control Important

The regulation of heat by a look at the fire, by the feel of a door, by spitting on the fan housing, seems a silly proposition on a plant with an investment of almost $100,000.00 when proper regulation of drying and firing means the difference between a profit and the sheriff, but they are by no means uncommon. We have some remarkably good guessers in the industry but the man who guesses at temperatures also guesses at his bank account.

The Booster Furnace

The booster furnace on waste heat driers is the offspring of slow kiln turnover and poor regulation. It may and should be eliminated. It is possible,

in most materials and products, to turn a 28 x 32 foot kiln twice a month. If that is done there will be little necessity for the booster furnace, with its soot and sulphur, or the absurd expense of coke or blacksmith coal for its firing.

Kilns are sometimes allowed to stand twenty-four hours to rid them of sulphur fumes, an unnecessary loss of time if the ashes and clinker are removed from the kiln while still hot.

The final heat should be removed from the kiln by a cooler or goose neck to the crown. A kiln at 500° to 600° is of little benefit to the drier but is often left on to cool the drawing crew and the booster fired to make up the difference.

Waste Heat Driers not Economical

It might be considered reactionary to recommend the elimination of the waste heat drier for the sake of economy and better product. We are divided between two schools, one of which would make the entire plant a synchronized unit and another which would make a unit of every piece of equipment. The waste heat drier works neither way.

A direct-fired, radiated heat drier will work as a unit or will synchronize and is much more easily controlled in temperature and circulation. It obviates a large percentage of objectionable fumes in contact with the ware, preserves equipment from destruction and operates without power. Against these advantages are the items of fuel cost and labor of attendance, both of which seldom exceed fifteen cents per ton.

The more drier operations I observe and the more I contrast the results obtained by the two types, the more I am convinced that waste heat in drying is a misnomer and that it actually is waste, no heat and little drying.

Driers Should Operate at Capacity

Driers are usually short a few cars to fill the tracks and stubs. This is a source of difficulty in operation and regulation, as it is impossible to obtain 100% efficiency from less than 100% apparatus.

These recommendations are not theoretical. They are in actual practice. For example, I have a record of drier operation where the trackage was increased 21% and the car equipment 34% resulting in an increase of 53.3% of dried product. That is, 90 cars per day were considered the limit and an average of that number had never been obtained, but with these additions and with care in regulation, together with the increased heat which was available, the output of the drier reached a daily average of 138 cars.

Many faults of design and construction exist, some of which can be corrected with little expense, others only by a new drier, but the ability to observe conditions and devise the remedy must be in the operator.

I have in mind a plant where sixteen tons per tunnel are dried and another where less than seven are the tunnel output product and material

are similar. I have also in mind a plant where it is said to be impossible to put dry press ware successfully through a waste heat drier, but the clay from the same vein is shipped one hundred miles, made into dry press brick and dried in a waste heat drier. I mention these inconsistencies to emphasize what I have often stated: that the industry needs common sense as well as technical research.

2131 S. Center St.
Terre Haute, Ind.

HOW IMPROVE THE HEAT ECONOMY OF GLASS TANKS?

By S. R. Scholes

ABSTRACT

Less attention has been paid to furnace design than to glass-working machinery, because fuel cost has been a relatively small item compared with labor. Some of the suggested means for raising fuel efficiency are: ports designed to give a better mixture for combustion, and a better spread of the flame over the glass; insulation, wherever the refractories can stand it.

Until recent years, the cost of fuel for glass-melting tanks has been one of the lesser items of cost in glass manufacture. The tank itself is hardly a generation old as a device for melting glass, and its development was contemporaneous with the quantity production and prodigal use of natural gas. At the same time, skilled labor became increasingly dear, so that inventive effort was applied particularly to the mechanical working of glass, with pronounced success.

Accompanying glass-working machinery came increased tonnage, requiring the steady maintenance of high temperatures for its melting. In the last few years, natural gas has been largely replaced by other fuels, chiefly producer gas; and this latter fuel, because of the high prices of coal and labor, now costs more than the natural gas of pre-war times.

Therefore, although the fuel cost is still small in comparison with other items entering into glassware production, it is large enough to warrant earnest efforts at reduction. The efficiency of glass tanks is low. If 10% of the heat applied is found in the glass at its highest temperature, conditions are exceptional. Thus an increase of efficiency up to 20% would cut fuel bills in half, and any real improvement in furnace design or operation can show good returns.

Improvement could almost certainly be made in port design—to name at once that point where the gas meets the air, combustion begins, and the form and character of the flame is determined. We now simply provide holes in the side-walls, through which we alternately pour flame gases into the furnace, and remove the spent products of combustion. Where producer gas is used (and this is the fuel considered in the present paper) the mixing with air is poor. In some cases a stream of air sweeps

across the tank above the flame, not mixing with the gas or taking part in the combustion until the outgoing port is reached. This is obviously wasteful. Design that permits this faulty mixing is based on an exaggerated notion of the relative lightness of producer gas as compared with air. As a matter of fact, the specific gravity of producer gas is nearly unity. And when the air is hotter than the gas, considered an excellent condition for good combustion, the air often becomes specifically lighter. Then in a port designed so as to carry into the tank a stream of air above a stream of gas, flowing parallel, the mixing is bound to be incomplete. Some arrangement must be applied that will insure better mixing, so that complete combustion, a shorter flame, and no unused air beyond the small excess necessary for good burning, shall be the established conditions.

Better mixing will result in higher flame temperature, which is recognized as an aid to heat transfer. And of course the effective transfer of heat is one of the fundamental requirements for furnace efficiency.

Another change from the usual style of port that should improve the transfer of heat to the glass is to make the ports wide enough to cover a larger area of the tank with flame. Most tanks now throw across the glass narrow streams of flame, whose combined width does not make up half the length of the glass surface. Between streams there are areas of glass not directly covered by flames, receiving radiated heat from a greater distance and therefore less effectively. Spreading the flame to a greater width should permit the port openings to be shallower and the crown of the furnace lower, with less unused furnace volume.

But the greatest loss of heat in the present tank occurs through radiation. Clearly, since we must continue to heat the walls as hot as they are at present, this radiation would go on, regardless of more effective application of heat. Insulation is the remedy, but its application is limited by the endurance of the blocks and refractories. There is as yet a lack of data on the effect of insulating, for example, the crown of a furnace, which would seem to be the logical place to start covering against radiation loss. So far as the actual fusion temperature of silica brick is concerned, the cap should stand insulation, but it is somewhat uncertain what the effect of the alkali dust and fume from the batch might be, if the cap were insulated and therefore became as hot as the glass itself. There are advocates of block-insulation, but it will take time and step-by-step experimentation to determine what the results of this procedure, so diametrically opposed to current practice, will be. The insulation of checker chambers is an accomplished fact in many cases, with good results. The developments along the line of insulation in the next few years should be interesting to observe.

Federal Glass Co.
Columbus, O.

GLASS AND REFRACTORIES SYMPOSIUM[1]

S. R. SCHOLES: Mr. Montgomery and Mr. Geller have presented excellent papers. In discussing the general theme of the attack of glass upon its retaining walls, I wish to bring up one or two characteristics that may be of interest.

A specific illustration of the difference in rate of corrosion, depending upon the position of the surface attacked, was recently presented when a tank that had been used nearly a year for pressed ware was tapped nearly free from glass before it was let out, leaving the walls exposed for examination. In the working end, certain channel blocks were set in the wall, flowing glass to feeders. These channels projected a few inches through the wall on the inside. One was examined in detail.

The corrosion of this inserted channel block had taken place almost entirely on its under side, that is, on a surface lying horizontally above (but immersed in) the glass. Here were found pits in the clay and "stalactites" of clay in varying stages of solution hanging from it. The clay had dissolved away, to the extent of about two inches from an original four-inch thickness. The upper surface of this channel block, over which at least 1600 tons of glass had flowed during its life, was smooth and scarcely attacked at all. (See Fig. 1.)

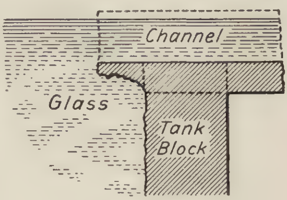


FIG. 1.

This behavior is just what would be expected, if clay with a true specific gravity of approximately 2.70 dissolved in glass having a specific gravity of 2.45, forming an argillaceous glass, or clay-glass solution, specifically denser than the original glass, and therefore inclined to sink in the tank as it formed on the surface of blocks.

By thus sinking and flowing away from surfaces facing downward, this solution would expose fresh surface for attack, and such surfaces, *i. e.*, facing downward, ought to be corroded more rapidly than upward-facing surface. On the latter, the formation of a clay-rich, viscous glass ought to serve as a protection against further corrosion, after a slight initial attack.

The same relative results may be observed when the bottom of a tank is considered, that is, how little it is corroded in comparison with the side

[1] R. J. Montgomery, "Present and Future Walls for Use against Molten Glass," *Jour. Amer. Ceram. Soc.*, **8** [4], 205–15 (1925).

"Developments in Glass and Glass Industries Refractories during the Year at the U. S. Bureau of Standards." Presented by R. F. Geller. Mr. Geller made an informal presentation of data. The paper has not as yet been released for publication. This Symposium was presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, February, 1925.

walls, particularly when we consider how rapidly the cover block of the throat is corroded compared with any other part of the tank.

Lately I observed a throat cover block that became a good deal more ruddy on top during a two-week shut-down, when no glass was flowing through the tank whatever, but the corrosion was taking place, and gradually letting it dissolve down thinner. It must be said, in all fairness, that the cover block being colder than the glass, we should expect the convection current to take glass away from it. It must also be said that the sidewalls being coated with glass would have the same convection current flowing downward. Therefore, I was particularly interested to note that in the tank which Mr. Geller described, the block which was totally immersed in the glass, had no cold outside, and showed the same corrugations where the glass flowed down.

In reading that portion of the paper, Mr. Geller mentioned the upward current, but I think here it is much safer to assume a downward current in the light of other experiences such as shown in Fig. 1.

There were several points in Mr. Montgomery's paper that I would like to expand upon a little bit. While saying that any refractory clay may be considered a glass pot clay, we may at the same time announce the opposing dictum, that all clays are attacked by glass. That is by no means an optimistic view, but it seems to me that that is exactly the view we are obliged to take, because we have not yet found anything, nor do I think there is anything, that we can afford to build into walls for retaining molten glass, that will not be attacked.

It is simply a question, as Mr. Montgomery pointed out, at the close of his paper, of proper compounding and constructing both with pots and blocks, to get the best results out of the material.

Glass is apparently an almost universal solvent for oxides. Inasmuch as we can scarcely hope to find substances other than oxides of which to build these walls, it is unlikely that we shall ever get anything insoluble. The principles governing the attack of glass on pot walls and tank block walls are practically the same, but there are one or two little differences that I can mention.

In the case of the pot wall, the fire is all over the outside. Therefore the pot wall is at all points along the side at any rate as hot as, or hotter than, the glass, so that any firing shrinkage that is taking place will tend to make the structure closer as we go from the inside to the outside. As corrosion takes place it finds a wall denser than the part eaten away.

In the tank block, on the contrary, we have the glass on the hot interior and the cold wall on the outside, so that if firing shrinkage does take place (if the block has not been fired to as high a temperature as it will ever reach in the tank), we shall have actual fissures open up on account of the firing shrinkage. And as the glass corrodes the block away it is always

meeting a more open structure than that which it has just succeeded in dissolving.

The point is made by Mr. Montgomery that we all appreciate that the tests of new block material or pot material take a great deal of time, and manufacturers are reluctant to undertake them. In that connection if the glass companies which we represent were only organized they could undertake these things coöperatively and a great deal might be accomplished with relatively small expense for any individual concern. I realize that certain economic questions are involved, competitive questions. Looking at it from a technical standpoint, however, it would seem to be an excellent thing to hope for.

In my estimation, the virtue of German pot clay lay, as the speaker said, in the fact that it was easily fired to a body of relatively low porosity. But that, we must remember, was at the sacrifice of refractoriness, and it would seem that it would be far better to do as Mr. Montgomery says we have unconsciously done, swing toward the more highly aluminous clays that are more refractory, fire them hotter, and secure this non-porous structure by means of heat in a refractory body, without making use of the more siliceous clay that has this lower melting temperature.

The corrosion of the walls by the glass is essentially a fusion process. One of the most striking things I ever encountered in work in chemistry, was in connection with a couple of organic compounds which were isomeric, but of different structure. One melted at about 25°C, the other at about 60°C. When we took a crystal of each and laid them together on a watch glass, the result was that they instantly fused. They melted by reason of the contact. A similar action takes place in a pot or against the wall of a tank block. The contact of two dissimilar and yet related silicates results in mutual lowering of fusion point, so that at the surface of contact we have a lowering of fusion point where it actually flows away and becomes a part of the glass itself.

In considering, then, the best wall for retaining glass, I am more and more inclined to believe that refractoriness is the prime consideration. What we want first of all is a wall that will not melt, and next we must have a wall that is not penetrated by the glass. The glass must not soak into it. We must avoid porosity. In order to get the requisite strength we are obliged to have a certain amount of flux in the clay. We are not going to succeed in building a satisfactory block or pot composed entirely of alumina and silica unless we go to extremes in the firing process. All of our satisfactory clays for such purposes contain what Mr. Montgomery mentions as fluxes. That is to say, principally such things as feldspar, and the alkaline content is usually taken as a measure of the feldspar content. The more alkali, of course, the stronger wall we shall have, the more easily the clay is fired to a strong body, but at the same time the more

we have sacrificed its refractory character, which may be held as the most essential property that the wall has.

J. L. CRAWFORD: It is interesting to note the methods used in arriving at the mixtures for making these refractories, as compared to the method suggested by Dr. Sosman.[1]

The refractory manufacturers would make up a number of tank blocks or pot mixes and actually test them out on a small scale, by methods such as that given by Mr. Geller for testing the resistance to corrosion. This method usually shows one mix to be slightly better than the rest, and this is the manner by which most mixtures have been, in the past, selected.

Some very good results have been obtained, and it is interesting to reason out a theory in support of these results. Mr. Montgomery brought out the fact that highly siliceous blocks or pots have been found to give very satisfactory results for certain glasses. We well know that siliceous clays are not as refractory as some of the more aluminous clays, such as kaolin, yet they have been found to be more resistant to corrosion. This is due maybe to the fact that kaolinite (Al_2O_3–$2Si_2O_3$) is not stable at high temperatures and that it quite rapidly breaks down to alumina and silica, then recombines at a temperature of 1350°C, forming mullite and silica. This later reaction takes place very slowly at the temperatures to which refractories are fired.

Examination of a commercial tank block, fired to this temperature, will probably show a very small percentage of mullite. When kaolinite breaks down into alumina and silica these constituents are in a form which react with the glass, far more readily, perhaps, than crystalline silica, such as is found in siliceous clays. We well know that a crystalline compound goes into solution more slowly than an amorphous compound, such as alumina and silica, set free from dissociation of the kaolin.

As I see it, according to Dr. Sosman's theory, a siliceous clay will more rapidly reach its stage of equilibrium under the heat treatment we now give tank blocks, and while such blocks do not entirely resist corrosion, they are corroded more uniformly over the entire surface, which means less rapid disintegration of the block and longer life.

No doubt there will be synthetic materials developed which will be an improvement over the clays now used but there still are possibilities of better selection of clays and better methods of preparation, such as in the washing of the clay, the grinding and tempering of the mixture, etc.

I am of the opinion that increased tank life can be obtained by a means other than insulating. Figure 2*b* shows the insulation construction. We well know that there are glass currents washing down along the side of the wall, as shown in Fig. 2*a*. We can readily see that the glass at *A*, coming into

[1] See *Jour. Amer. Ceram. Soc.*, **8** [4], 191 (1925).

contact with the flux block at B will take part of the flux block into solution and become saturated. These currents may be due either to convection or to the fact that the saturated glass becomes heavier and passes down to the bottom of the tank, as shown at C. This tank-block-saturated glass, passing down along the side of the block, protects the lower portion of the block from further corrosion, and we soon have the block taking the form shown by the line at B or eventually D. As the flux block rapidly takes the shape shown by the line B in Fig. $2a$, it would seem that this shape is one which promotes resistance to corrosion.

By giving the entire side wall an inclined face, or just the upper course in a deep tank, as shown in Fig. $2c$, the glass A, coming into contact with the flux block at B becomes saturated for the given temperature, and is held *in situ*, which prevents further corrosion of the block by the glass. By giving the inclined face horizontal corrugations, we may still further

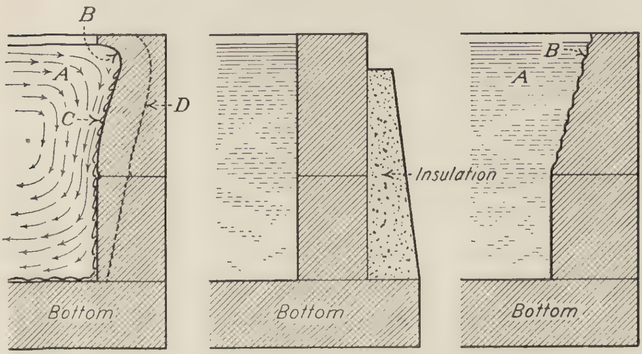


FIG. $2a$. FIG. $2b$. FIG. $2c$.

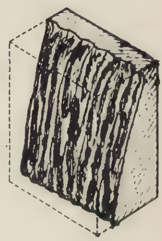


FIG. 3.

decrease the tendency of the saturated glass to pass down along the face of the block. The inclined face also gives greater thickness to the block in the bottom of the tank, which, as we have heard in connection with the discussion on insulation of tanks, is a decided advantage, in that it tends to increase the temperature of the glass in the bottom of the tank, giving greater melting volume.

Figure 3 shows the rough corrugated face ordinarily assumed by a tank block on corroding. The block in Fig. $2b$ has the advantage in that the inclined face is smooth and presents less surface in contact with the glass.

We believe this design has all the advantages of an insulated tank and has an added advantage, in that it holds the flux-block-saturated glass *in situ* and thereby prevents further corrosion, whether this corrosion be due to convection currents or to difference in specific gravity of the unsaturated and saturated glass.

G. V. McCauley: The shelving action, on the side of the tank block

where there is a horizontal seam present, or on the underneath side of the throat of the cover block, seems to be due to factors other than those described, although those which have been described no doubt affect the solution of the block.

There are a series of holes that seem to have been drilled upward into the block, and run together on the sides. The more resistant the block is, the deeper will be these holes. I have seen them in blocks as deep as four inches, and no larger than your finger. They are not fissures to start with, because they are too round for fissures. In very resistant high alumina block I have seen them perfectly rounded. They cannot, therefore, have started from fissures. If the glass is broken out of these holes, you will almost invariably find in the top of each hole a pocket which does not seem to be filled with glass, but which might have been filled with vapor or gas. The erosive action seems to be a rapid one upward.

The erosion at the glass line is always very rapid compared with that at the side of the block. It seems as though we must attribute some of that to the motion of the glass, due to changes of surface in the glass by dissolving some of the block. This may be either a decrease or increase in surface tension. Either one will produce the motion and motion will always hasten erosion. There must be some of that surface tension effect in this drilling upward. If we wish to eliminate any chance of the gas getting under the block, then the sloping block Mr. Montgomery speaks of will do it. He has given an illustration and from my own experience I have constructed troughs where we flow glass from one tank to another and deliberately run the glass high enough to form a thin shelf over the top block. We get absolutely no cutting on the sidewalls, and the small amount of glass over the top will save the top of the block.

The smooth surface on the upper side of the horizontal shelf, then, is not to be considered as due entirely to droppings of products of solution forming this edge. If the glass merely rests on top of the block, it will form a layer of crystals varying in depth, depending on the temperature of the glass. These facts, I think, show that the drilling action which always takes place upward is accompanied by the presence of a gaseous atmosphere in the presence of which erosion is accelerated.

J. C. HOSTETTER: I am very glad indeed to have that point brought out. In Dr. Sosman's paper, dealing with fundamental principles, he spoke of mechanical conditions that would change the rate of reaction between the glass and the refractory. Surface tension was not mentioned.

I am quite sure from what I have seen so far, that there is merit in Mr. Brownlee's idea of insulating. When we insulate flux block on the outside, we can cut down the downward convection flow of the glass to a large extent, but I am still wondering about the surface tension action. When maintaining a constant level in the tank, there is a very violent cutting

right at the surface level, and in one extreme case, completely through in the working end. In this case it was not insulated in the true sense of the word. However, we did have a layer of fire brick on the outside of the flux block.

C. O. Fairchild: The idea is that the glass contains dissolved gases which escape at an under surface. A trapped bubble of gases, such as water vapor and carbon dioxide, in equilibrium with glass at high temperatures, would produce a combination of great corrosive power. A retained bubble would dissolve its way upward.

G. V. McCauley: On a block taken from a tank which has been in operation not long enough to wear the block out but long enough to score it, you will find the lower block in the tank probably nearly perfect, with a little round corner at its upper edge. This block may be eaten quite badly and the surface, instead of being smooth, will have the appearance of being full of little holes. The closer together these holes are, the smoother will the surface appear. If the block is very resistant, those holes may ultimately go up quite far, and get quite deep before they actually run together. In that case the appearance of the surface is something like the roof of a cave, with stalactites. The whole structure seems to be one of numerous nuclei of erosion, tending upward, and as they go upward, they spread out a little at the base and run together. As I say, the more resistant the clay, the deeper those holes ultimately become and the more pronounced they are.

I have seen the same action in a porcelain tube that had broken off and fallen into the tank and by some accident or freak of nature, the thing split lengthwise. When the tank was drained this tube was found split almost in the middle and lay on the bottom of the tank with its wall convex upward. At the upper edge, all along the length, about a quarter of an inch apart, were holes less than $^1/_{16}$ of an inch in diameter, just as drilled. This drilling was done by gas trapped underneath.

You get this drilling underneath a throat cover block. It is never smooth, but always has icicles hanging. If you will observe them closely you will find the hole-like formation. If you chance to find one that is full of glass, on knocking the glass out that there is a fairly round opening that gives the impression of never having had any glass in it, but full of gas or vapor.

S. R. Scholes: Would not the contraction of the glass leave an opening up in the upper end of those holes?

G. V. McCauley: It is possible, but I think there is evidence enough to show that it is not necessarily so.

In case of clay blocks being used for a skimming action in feeder operation, our practice is to set these blocks about half an inch into the glass. They will very soon cut off at the glass line. If you catch them when they

are not quite cut off you will find these icicles very isolated. There may be just one-tenth of the original block structure left; the rest is cut off, but even above the glass level you will find these holes filled with glass. This gas cavity will be found just above the glass. There you would hardly expect enough vacuum in cooling the glass to produce that bubble.

C. E. Fulton: I have seen that same type of action on the under side of a floater. In fact, most of the floaters I have seen taken out have that structure.

R. F. Geller: If what we are talking about is true, then we ought to build a tank with a cross-section like *A* where we would not get that action, but in this experimental tank would we not get a good test if we built a tank of a cross-section like *B* (Fig. 4)? Would we get a better test block in a laboratory if we built it as indicated and judged the relative merits of the block by the attack at *B*?

G. V. McCauley: If you run the tank long enough you will get that without the trouble of making it that way.

R. F. Geller: That is what we do not have time to do.

G. V. McCauley: We have large bulb tanks. The refining end of them will run for perhaps six years without having to be repaired. They are only 24 inches deep and the blocks are continuous from the bottom to the glass line. We have to change those working-in blocks in time because the glass has actually dug into that seam between the bottom block and produced a cut so bad that there is not enough surface left to support the block. We have to take them out because they cut at the bottom instead of at the top. In there the temperature is only about 1200°C, and the action is slow.

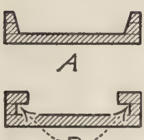


Fig. 4.

Wm. Brownlee: I would suggest that that may be due to high pressure, together with the other circumstances.

J. C. Hostetter: Pressure due to the weight of the glass?

Wm. Brownlee: Yes.

J. C. Hostetter: That is a factor, of course.

R. R. Shively: Might these holes not be due to arsenic left in the batch?

G. V. McCauley: Well, perhaps they are. I do not know how much arsenic is used. It may be that that does materially alter surface tension. It takes a very little amount of material in some instances to alter surface tension, enough to produce violent effects. As an illustration, stick a piece of camphor into a beaker of fresh water. If a few grains of dust are placed on the water surface, they will gradually creep up until they seem to just touch the camphor at the surface line. They then like a flash will go to the outside edge of the beaker. The whole surface of the water will be in violent motion, due to altered surface tension. If after five or ten minutes

you cannot measure any erosion on the camphor stick except at the water surface there will be a material cut, due entirely to the motion on the surface of the water.

When I first spoke of surface tension being altered I had in mind the alteration produced by the solution of the block itself. It may be altered either way to produce a motion.

J. C. HOSTETTER: I wish we had some real information on surface tension of glasses at various temperatures. The University of Illinois published some information on a limited series but the investigation was not carried far enough to give us the effects of impurities. I believe there is a great deal in the notion that erosion is due in part to changes in surface tension.

R. J. MONTGOMERY: There is one point I would like to bring out and that is the relation between the composition of the pot and the quality of the glass that is obtained. In using pots I am sure there is a direct connection and I imagine the same is true in glass tanks.

In Mr. Geller's study of the relative attack of glass upon various commercial tank blocks, he does not mention anything about the quality of the glass made in the experimental tanks or what effect the corrosion of the tank had upon the glass. Without doubt, alumina is harder to incorporate in the glass than silica and when we talk about high silica batches and high alumina batches we must take into consideration the rate of solution into the glass of the material corroded from the walls. This point should be stressed, as it is of more importance than most people realize. I do not believe that the full value of any experimental work may be obtained if the quality of glass is not taken into consideration.

J. C. HOSTETTER: Mr. Montgomery is making glass that cannot be sold unless it is optically perfect. I believe the rest of us in general are not making that. I gather from Mr. Geller's paper that the object there was to study corrosion on the block, and I should think that the more corrosive batch he could use the better, irrespective of the quality of the stuff that came out, as fundamentally he is interested in the results on the block.

R. J. MONTGOMERY: I think the subject of quality is coming more to the front all the time and I am not yet satisfied that my point is not well taken. We look forward to a time when we hope to obtain good quality glass from a tank. The plate glass industry is a large one and the quality requirement is high. We now get plate glass from tanks. Mirrors are made from plate glass and cordy glass cannot be silvered. I am sure the quality of the glass is important. Fundamentally we are making glass and not pots or tank blocks.

C. E. FULTON: In the plate and window glass industry the quality of glass produced with a given pot or tank block is of the greatest importance. Defects introduced by the pot or tank block such as stones or cords de-

crease the value of the product and if present in too great a quantity they will make the glass unsalable. It has been our experience that highly aluminous refractories cause stones and cords (or ream) to a very much greater extent than a highly siliceous pot or tank block. In our work the quality of the glass produced has been considered of greater importance than the life of the refractory.

R. F. GELLER: Mr. Montgomery has brought out an important point. There are variations in every trade, and for that reason we have limited our first work to that portion of the glass industry which, if my information is correct, has the largest production in the country, the glass bottle phase. Our work is limited to that phase, and what we are using at the present time is the commercial batch furnished by a bottle glass company. After listening to a glass man and all the troubles he has to turn out a good product, we have made no pretense of endeavoring to turn out nice glass. We are just making tests primarily of blocks, although the glass obtained is pretty fair.

F. C. FLINT: It is a long way from the glass Mr. Montgomery makes to that used for bottles. We cannot seem to attain the quality, not that we would not like to, but we just cannot get that quality and maintain production.

We melt the glass in tanks of considerable size, and are maintained from one week's end to the next, with considerable uniformity. We have three factors to consider. We want to get all the glass out that we can, up to the point where it ceases to be melted, evidenced by seeds. The block has little to do with that. It never affects that. The other is color. We have managed to maintain a good color, regardless of whether it has been in a tank with very good blocks or a tank of blocks that are so poor that the tank lasts not over five months. The only contribution that the block gives us, so far as poor quality is concerned, is to make cords that are so evident that they destroy the quality of the bottle. We always have cords to a small extent. We do not produce them by stirring up the glass. They are, however, present. When the cords get numerous enough to cause the breakage of the bottle, the tank block does not last very long.

DISCUSSION ON "THE MEASUREMENT OF EXPANSION OF FIRE BRICK AT VARIOUS TEMPERATURES"[1]

W. A. CARTER: In our construction of large boilers where we have the hollow wall construction, nine inches of hot wall and an air space, a good deal of care has to be exercised for expansion. It is a practice of our company to lay up the brick in horizontal courses, rubbing each course of

[1] F. A. Kohlmeyer, *Jour. Amer. Ceram. Soc.*, **8** [5], 313 (1925).

brick with a carborundum stone. We then put in a quarter inch corrugated paper every eighteen inches. Care should be exercised in using the paper where it will be reduced to ash. There have been cases where it did not burn out. These tests justified just what expansion to take care of.

S. S. COLE: In these tests, did you find hand-made or machine-made brick to be the most suitable?

F. A. KOHLMEYER: Our tests indicated that dry pressed machine made brick are the best for our use. The four brands selected for a further trial in service are manufactured in the Missouri district.

S. S. COLE: How is the fusion point of the ash obtained? Do you run them through the pot furnace or by the standard method for coal-ash?

F. A. KOHLMEYER: At present we are using West Virginia and Kentucky bituminous coals in both our stoker fired and pulverized coal burning furnaces. The ash of this coal has a fusion temperature of 2500°F or higher. Our coal-ash brick cone softening temperature tests were conducted in a gas-fired Surface Combustion Co. Volcanic Testing Furnace.

S. S. COLE: Do you have a small crucible inside?

F. A. KOHLMEYER: The cones made of composite samples of pulverized brick material and coal ashes were mounted on alundum cement pats and heated in a crucible in the furnace. The results could be observed by looking into the top of the furnace.

S. S. COLE: Was the operation under oxidizing conditions?

F. A. KOHLMEYER: This furnace was operated with oxidizing atmosphere.

S. S. COLE: In connection with the testing of brick under load and the measuring of the expansion of the same, Mr. Kohlmeyer spoke of the use of a transit. In some similar work with silica brick, we attempted the use of a transit but our results did not check. This might have been due to expansion of the furnace, because we used a slightly different method. Due to this error we are now using a cathetometer to measure the expansion of silica under load. This method gives us a very quickly obtained result, because we make a direct reading of the expansion upon the scale. The only difficulty we found with this method was the flame interference, but overcame this by use of an air blast upon the end of brick when making a reading.

As to the slagging test, where the coal ash penetration into a fire brick is measured, I believe that this test is not a satisfactory one or one exemplifying the service to which a brick is subjected by coal ash erosion. The best method, I believe, is where the coal ash is melted and runs down over the face of a set of brick, allowing the brick on being dissolved to flow off and new coal ash to take the place. Where a wall is on a slope, this action is what occurs in a boiler.

The ash ought to be the same as that in the coal being used and is a flue dust, collecting on the tubes of the boiler and on the arches. By the

use of an ash of this sort the same conditions as in a furnace are given the brick, and the brick on examination after testing will give a good idea as to what their service will be in a boiler.

D. W. Ross: In connection with some optical pyrometer readings, the exact length being hard to read due to the waves in the atmosphere, we found that in laying a small piece of the other brick, there would be a straight line across there and a line across the base. The surface would be slightly chilled for three or four seconds and it would appear that that line would show up so plain that there would be no change in temperature of the brick. They came out very clear and it was not at all difficult to get a reading.

F. A. Kohlmeyer: A holding tile is used in the construction of our pulverized fuel furnaces which is exposed to rather severe spalling conditions. This tile extends from the exterior to the interior face of the wall passing through the air space in the center of the hollow wall. Approximately 80% of the air required for combustion passes through the hollow wall thus cooling the refractory exposed to the fire and chilling the holding tile at a section near the center.

R. F. Geller: In the work we did which was reported last year, we worked some 42 bricks and as a result of the work, out of the 42 we picked out what we called the ten best, and they were based on the quenching. Several of those ten were dry pressed.

W. A. Carter: In the construction of our large boilers in which we have hollow walls, there being 9 inches of hot wall, a 12-inch air space and 9 inches in the outer or cold wall, a great deal of care has to be exercised in providing for the expansion of the brick in the hot wall. It is our practice to lay the brick in horizontal courses, rubbing down each course with a carborundum rubbing stone so as to provide a thin joint. In each horizontal course there is inserted every 18 inches, or thereabouts, a $^1/_4$-inch corrugated paper, which burns out and leaves space to provide amply for the expansion of the brick. Care should be exercised in selecting a paper that will burn to a small amount of fragile ash. There have been cases where unsuitable paper has been used, that is, paper that did not burn out properly. In these cases the brick were not free to expand the required amount without wrecking the setting.

H. W. Brooks: In our consideration of slagging problems of boiler furnaces we are often inclined to concentrate attention on only one of the four major slagging problems, namely, slag erosion. With Eastern bituminous coals containing ashes of high fusion temperatures the principal slagging difficulty does not originate from erosion but from adhesion. This results in rapid destruction of the furnace walls in the removal of the built-out slag through the impact of firemen's tools, and is the principal cause of refractory maintenance in furnaces using these coals.

In the central district of the United States, however, where there are bituminous coals containing ashes of medium low temperature fusion points there are three other principal slagging problems which in the order of their importance are as follows: (1) slag erosion on furnace walls; (2) slag formations within the fuel bed itself; (3) slag formations on and between the first and second rows of boiler tubes which eventually plug up the furnace so that the necessary drafts will no longer pass for the desired boiler ratings.

With regard to the first problem, erosion, it is probable that the ash-brick cone test gives some measure of two of the four factors which must be considered in its analysis. These four factors are: (*a*) slag viscosity at furnace temperature; (*b*) viscosity of bond clay in refractory at furnace temperature; (*c*) porosity of refractory at furnace temperature; (*d*) mechanical strength of refractory at furnace temperature. The softening and flow intervals of an ash-brick cone considered in conjunction with the cone softening temperature probably will give a direct measure of the first two of these factors. This data, however, tells us nothing of the porosity of the refractory nor of its mechanical strength at furnace temperatures. Both of these factors must be considered in an analysis of slag erosion. The ability of the slag to penetrate and commence to decompose a refractory is obviously a direct function of the refractory porosity. Mechanical strength of a refractory must be considered for oftentimes small pieces of the refractory are washed down by the slag and an examination of the slags of boiler furnaces using Middle Western coals often shows these small pieces washed down with apparently but little slag absorption.

Refractory porosities and mechanical strengths at furnace temperatures are easily determinable with tests at present formulated by the A.S.T.M. It seems, therefore, well within the range of possibility for those interested in refractory research to devise a formula for slag erosion to include the four factors mentioned above from which formula a refractory brick buyer, after running the ash brick cone test at furnace temperatures, could predict what service he might expect with a given refractory, a given coal and a given furnace.

In regard to the problems two and three, of slag formations within the fuel bed and on the boiler tubes, these are purely functions of the coal ash itself, and hence are not matters of particular interest to refractory engineers.

F. A. Harvey: The manufacturer can do nothing else than welcome all of the tests which the consumer makes and the more he can obtain concerning his own uses the greater chances the manufacturer has of supplying him the refractory; but there is something which is more vital to the manufacturer on first sight than it is to the consumer.

If the consumer decided on some test, such as the spalling test, which he is going to take as a criterion to discard a large number of refractories, he avoids all danger of getting a refractory into his setting which will cause him trouble, but he also runs the chance of excluding the number that would have an opportunity of going in.

I had an occasion about six months ago to visit a company who were making tests on refractories and the criterion they used was the fusion point. They were very frank in allowing the manufacturer access to their results and among other brick which were rejected on the basis of fusion point, there was one which has a national reputation for success yet, on the basis of lower fusion temperature, this brick was excluded. It was in my mind unfair to that manufacturer. There is a chance in this case that this spalling test is excluding certain refractories that would give you satisfactory service. This is the point that you must consider.

R. F. FERGUSON: Mr. Kohlmeyer, you have not told us what you expect to find. Have you specifications?

F. A. KOHLMEYER: We have drawn up specifications for fire brick, but consider them as tentative and subject to revision.

L. C. HEWITT: We note the spalling factor was given prime importance in making tests and I have been trying to determine in my own mind just how important spalling is in large powdered fuel settings. It is, of course, of prime importance that the ceramic engineer, when devising mixes and processes of manufacture for producing materials, have thoroughly in mind just what these conditions are, as well as the relative importance of the various destructive factors that influence the life of the brickwork.

I have been led to believe from my own observations that the tendency to spall in a powdered fuel furnace is not as great as it is in some stoker-fired types of furnaces, for the service factors affecting the life of the bonding tile are, of course, somewhat different from the type of brick themselves, due to the strains which these tile must withstand in holding the wall rigid, and would accordingly welcome any discussion relative to the importance of the various factors that should be taken into consideration in adapting refractories for powdered fuel service.

D. W. ROSS: In connection with some thermal expansion measurements which we made at the Pittsburgh branch of the United States Bureau of Standards in 1916, on silica brick at high temperatures, we found it very difficult to make exact readings of marks on test specimens exposed in an open fire, at temperatures in the neighborhood of 1350°C.

We found, however, that if the ends of the test pieces be ground plane, so that the traces of the ends are straight lines, and that other plane refractory surfaces be brought into contact with these ends, and the whole heated to any desired temperature in an open fire, and the fire be then momentarily shut off, that the lines of contact between the ends of the test

specimen and the adjoining pieces are plainly visible. This is because of a slight chilling of the surface of the test piece, whereas the interior as shown at the contacts, remained at the higher temperature.

With standard 9-inch silica brick, such as we used, it was possible to make cathetometer readings of these contacts and get the fire going again in a very few seconds, so that the specimen probably changed in size very little, while the readings were being made.

DISCUSSION ON "SOME FORMS OF SULPHURING ON EARTHENWARE GLAZES"[1]

K. M. Smith: Can you get sulphuring from natural gas?

T. A. Shegog: I have never seen it. I do not think it contains any sulphur. Natural gas and wood are about the only fuels I think in common use that do not contain sulphur.

K. M. Smith: You used only coal and oil?

T. A. Shegog: Yes.

K. M. Smith: How did you determine the sulphuric acid? Did you titrate?

T. A. Shegog: I precipitated with borium chloride and weighed.

A. V. Bleininger: I think Mr. Shegog has covered the thing pretty completely and it would be very difficult to add anything to it. There are all kinds of variations of the same difficulty and some times they are extremely hard to distinguish.

We had a case which might have been mistaken for sulphate effect but which was due only to a very high velocity of gases flowing around the saggers. The problem always is whether or not we are dealing with sulphuring and that is not quite so simple. Mr. Shegog brings this point out.

It is not the easiest thing to differentiate between sulphuring and the effect which is brought about by so-called airing, where we have too high velocities of kiln gases.

H. Goodwin: I should like to speak with reference to sulphur from natural gas. Perhaps some members will recall this question was raised, if I remember correctly, at the St. Louis Meeting in 1907 on a paper by Herford Hope on his experience at the Wylie China Company, Huntington, W. Va. It was found that we could get sulphuring from natural gas.

K. M. Smith: That raises another question. Will the sulphuring help crystallize zinc out of a high zinc glaze?

T. A. Shegog: Just what do you mean by a high zinc glaze?

K. M. Smith: About .245 equivalent. We developed crystals quite

[1] Published, T. A. Shegog, *Jour. Amer. Ceram. Soc.*, **8** [3], 148 (1925).

frequently in this high zinc glaze. They are very similar to those speckled spots on the ware you passed around. Would the little sulphur that could communicate either through the water or natural gas help centralize those crystals and start crystallizing?

T. A. Shegog: The glaze on those pieces contains less than 3% dry weight of zinc. I have had no experience with very high zinc content.

E. Schramm: Several years ago I carried out some experiments in an electric tube furnace in an effort to produce at will a typical sulphur scum and to determine the conditions of its formation. Since on burning coal nearly all the sulphur appears in the gases as dioxide it seemed likely that we must look to the dioxide rather than the trioxide as the source of sulphuring. Accordingly, I passed pure sulphur dioxide both dry and wet, mixed with varying proportions of air, over pieces of dipped ware at various periods of the glost fire. Scum was produced with either wet or dry sulphur dioxide only at the upper end of the glost burn.

The "polka dot" scum recalls some freak pieces of ware from a glost kiln which were impregnated with carbon apparently carried down from the kiln gases and trapped by the melting glaze before it could burn out completely. The surface appearance of this ware was not unlike the "polka dot" scum referred to in the paper.

C. E. Doll, Sr.: It might be interesting to note our experiences in tunnel kiln operations as bearing out some of the data that was read in this paper.

In firing a glost Harrop tunnel kiln we found, even using fuel oil wherein we had a specification of less than one-half of one per cent sulphur, that we were getting what is commonly known among the old school of potters as airing. In years gone by we used to think it had to do with airing. Experiments showed it was due to sulphuric acid deposits upon the ware during the early stages of the development of the glaze, and in order to demonstrate and prove this conclusively we made openings in the crown of our tunnel kiln.

We could take pieces of ware to which glaze had been applied and place these pieces of ware even inside, but not tightly wadded, let them go through the entire preheating zone of the tunnel kiln and they would come out with the glaze dulled by this deposit. We could go further along the kiln to where the kiln was beginning to show red, possibly at 1000° or 1200° and through an opening in the crown drop a piece of glazed ware and let that piece of ware travel through on top absolutely exposed. It would come out perfectly bright, showing that the attack in the deposit upon the ware occurred in the early stages of the glaze development and was affecting the ware at that time.

This proposition is such a problem that in designing the new kiln which we are about to erect we plan to use a muffle. While it will be a direct

fired kiln, yet in the preheating zone during which the ware is being brought up to 1000° or 1200°F, we intend to muffle that section so as to take out the gases and prevent this deposit from occurring.

DISCUSSION ON "COMPARISON OF ENGLISH VS. AMERICAN PYROMETRIC CONES"[1,2]

S. S. Cole: The Bureau of Standards conducted their investigation on cones in a muffle furnace so as to have uniform temperature control. The comparison was made to a point at which the English cone touched down. We found quite a number of variations in that respect and tests on all cones were run two or three times to check our results.

R. F. Geller: We only went up to cone 20, but in the range that we both covered it seems to check up very well. Mr. Cole, did you notice any bloating?

S. S. Cole: Bloating occurred at cones 14–16. It looked like boiling or bubbles.

R. F. Geller: While I do not have the charts with me and cannot make a definite comparison, it appears that the results which you obtained at Mellon Institute and those obtained at the Bureau, check as well as could be expected. In our work we noted bloating of the English cones in the range from cone 10 to cone 15, inclusive. Cone 19 also showed indications of bloating.

S. S. Cole: The temperatures given in the tables were obtained about 10 months ago from the Bureau.

R. F. Geller: Since the Bureau is at this time investigating as accurately as possible the relation between cone composition, softening point and time of heating, it is believed advisable not to refer to softening points obtained at the Bureau until this investigation has been completed. It is hoped that the results obtained will be conclusive.

S. S. Cole: It would be of interest to the users of cones if we could publish the temperatures of cones produced by the English.

R. F. Geller: It would, no doubt, be interesting to publish the softening points of the English cones as determined in England if we could state definitely how they were determined. Without that information, however, the data would be valueless and would only add to the contradictory temperatures already in the literature.

C. E. Bales: Last year at the Atlantic City meeting, Dr. Orton pre-

---

[1] See *Jour. Amer. Ceram. Soc.*, **8** [7], 462 (1925).

[2] Presented at the Annual Meeting, American Ceramic Society, Columbus, Ohio, Feb., 1925.

sented some data on cones to the Committee on Standards. Photographs were exhibited showing English, French, German and American cones and there was considerable variation. I think that if Mr. Cole had investigated German cones he would have found that they too vary considerably from American cones. Several years ago we used some No. 9 German cones in kiln firing, but when their cones were over, the No. 7 American cones would still be erect. We now use the Orton cone exclusively. The German Naval Specifications call for a fusion point of cone 34. In America brick softening at cone 32–33 are good brick and this makes me believe that our cone 33 is possibly equivalent to the German cone 34.

F. A. Harvey: One of the biggest difficulties that refractory manufacturers have is trying to tie these cones up with temperatures. We get specifications right along in temperatures. The cones do not measure temperatures. They are a measurement of quantity of heat, and without any disparagement of the work of the Bureau in their experiments to determine the temperature relations, we want to get out of everyone's minds the idea that the cone measures temperature.

R. F. Geller: We are not trying to tie up cones with temperatures. We are trying to tie up temperature and composition. We all know that when you get up in that range of 1500° or 1600° that the optical pyrometer is not correct.

A. F. Gorton: If we consider an actual case, for instance, in a very large kiln with a great tonnage where there is a vast reservoir of heat, the cone measurement of time, temperature, treatment or maturing as we speak of it, is a measure of the viscosity development. Viscosity or state of fluidity is a matter of time at temperatures above the softening temperatures of the more fusible minerals present. The melting point of a mineral crystal is definite but the melting point of a mixture of minerals is not very definite.

What is the softening point of glass? The only test is to subject the glass to a definite stress or load at a fixed temperature and note the rate of deformation.

To think of the cone as a measurement of temperature is no more scientific than measuring the deformation temperature of a cone or rod under a definite stress by putting it into a hot furnace at a fixed temperature and then measure it at the rate of deformation.

In large kilns the heating is so slow that when the cone goes down it is not actuated by the temperature but by the amount of materials in the cone that is sufficiently fused. Deformation, under definite stress, should tie up more nearly with the actual temperature.

F. A. Harvey: I think that we can safely leave the question of relation to temperature of cones to the work which the Bureau is doing and which undoubtedly will clear up this subject. To Dr. Gorton, may I say

that after several years of experience in firing silica and clay refractories the measure of temperature is not what the cones show.

R. F. Ferguson: Dr. Gorton's remarks are out of line with what we are trying to do.

A. F. Gorton: I want to point out that when you consider 70 or 100 tons of ware in a kiln, and you consider the mass of the cone, it seems to me that you will have to admit that you are measuring what the glass works tried to measure in regard to glass, and that you are rating the deformation with rather a small stress on an object that has a very small mass.

ACTIVITIES OF THE SOCIETY

NEW MEMBERS RECEIVED FROM SEPTEMBER 15 TO OCTOBER 15

PERSONAL

Francis E. Allen, 322 Sixth St., Ames, Iowa. Student.

Edward L. Bohn, 123 Saranac Ave., Buffalo, N. Y. Sales Representative, Dover Fire Brick Co.

Hewitt O. Fearn, 5248—17th St., N. E., Seattle, Wash. Ceramic Fellow, University of Washington.

Robert B. Hand, Y. M. C. A., Elyria, Ohio. Chief Chemist, The Pfaudler Co.

Fred E. Hilburn, Salina Inn, Salina, Westmoreland Co., Pa. Kier Fire Brick Co.

Everett O. McFadon, Karr Range Co., Belleville, Ill. Superintendent of Enamel Department.

Henry Marley, Salina Inn, Salina, Westmoreland Co., Pa. Kier Fire Brick Co.

Himansu Kumar Mitra, 221 Atwood St., Pittsburgh, Pa. Graduate Student.

Remington M. Murphy, 35 E. Pultney St., Corning, N. Y. Ceramic Engineer, Corning Terra Cotta Co.

Ralph J. Paddock, 2011 Chelsea Road, Columbus, Ohio. Fellowship with the U. S. Bureau of Mines.

Layton C. Pinckney, 1927 Waldeck Ave., Columbus, Ohio. Student.

Marie Regnier, 134 Sidney St., St. Louis, Mo. Secretary and Treasurer of the Silica Enamel Sign Co.

Paul John Slegel, 407 Welch Ave., Ames, Iowa. Student.

Fred W. Sontum, R. D. No. 2, New Castle, Pa. Superintendent of Shenango Pottery Co.

CORPORATION

Porous Products Corporation, Baltimore, Md., Frederick E. Kern, Vice-President.

Membership Workers' Record

	Personal	Corporation
Paul E. Cox	1	
Dover Fire Brick Co.	1	
E. A. Eigenbrot	2	
M. C. Gregory	1	
H. C. Harrison	1	
M. R. Hornung	1	
S. M. Kier	2	
W. A. King	1	
D. A. Moulton	1	
A. Silverman	1	
Hewitt Wilson	1	
Office	1	1
Total 15	14	1

PERSONAL NOTES OF MEMBERS

Robert J. Anderson, Consulting Metallurgical Engineer, of Pittsburgh, Pa., has requested that communications be addressed to 1658 Woodward Ave., Lakewood, Cleveland, Ohio.

M. L. Bell has been transferred from the Altoona, Pa. branch of the General Refractories Co. to Baltimore, Md.

Marion W. Blair, formerly of St. Louis, Mo., is living at 2131 S. Center St., Terra Haute, Ind.

E. A. Brockman, who is associated with the Roessler and Hasslacher Chemical Co. of Chicago, has requested that his address be changed to 526 E. 4th St., Lincoln Apartments, No. 18, Cincinnati, Ohio.

O. I. Chormann has moved from Niagara Falls, N. Y., to Rochester, N. Y. He is associated with the Pfaudler Co.

Roland J. Clark of Olean, N. Y., is located at the College of Mines, University of Washington, Seattle, Wash.

G. M. Grady, member of Class of 1925, Ceramics at Ohio State University, is located with the Northwestern Terra Cotta Co., Chicago, Ill.

R. B. Ladoo, formerly with the Southern Minerals Corp., Cleveland, Tenn., is now associated with the Colorado Fluorspar Corp., Cowdrey, Colo.

Garland Lufkin has been appointed to succeed L. H. Maxfield as corporation representative of the Illinois Glass Co., Alton, Ill.

Paul S. MacMichael of Auburn, Wash., requests that his mailing address be changed to 1190 Dexter Horton Bldg., Seattle, Wash.

D. M. McCann sends as his address University Club, Akron, Ohio.

Max Y. Seaton of the Sierra Magnesite Co., Porterville, Calif., is spending six months at Chula Vista, Calif., with the California Chemical Corp. Mr. Seaton will return to Porterville later.

Joe F. Straumford has moved from Portland, Oregon, to 1206 S. Ford St., Los Angeles, Calif.

Gail R. Truman has moved from Glendale, Calif., to Brazil, Ind.

W. W. Tsou, who has been attending Alfred University, has entered the graduate school in ceramics of the University of Illinois.

W. R. Wyckoff is affiliated with the Department of Ceramics, Rutgers College, New Brunswick, N. J.

BALTIMORE-WASHINGTON SECTION MEETING[1]

The first meeting of the Baltimore-Washington Section of the American Ceramic Society for the 1925–26 season was held at the Old Colony Club, Emerson Hotel, Baltimore, Md., at 7:00 p.m., October 3, 1925.

The meeting was opened with a fine chicken dinner, to which each of the twenty-four members present offered to do justice. The program opened with a paper by W. N. Harrison of the Bureau of Standards on the "Physico Chemical Factors of Enamel Suspensions." The object of this work is to study the factors affecting properties of enamel slips in order to control their working properties. The investigation has been carried on under two methods. The first to study in a fundamental way the mechanism of known changes in properties, such as the marked change in consistency which takes place when the electrolyte is added. The second is to vary the kinds and amounts of constituents and the length of time of the various treatments, and note the effect upon the properties. The paper brought forth considerable comment from Mr. Sweely, who suggested many new lines of thought which might well be used in the future work.

The second paper was by R. A. Heindl of the Bureau of Standards, entitled "A Progress Report on Sagger Investigation." Mr. Heindl told of the enormous amount

[1] D. H. Fuller, Secy.

of work which had been done on this problem, and gave a clean insight into the varied physical properties of fifty-one different sagger clays now in use in this country. From these results it is easy to see that there is room for much research work along this line. The paper is now in the hands of the Editorial Committee of the Bureau of Standards and will soon be printed in full detail in the *Journal of the Society.*

The program closed with a talk by B. T. Sweely of the Baltimore Enamel and Novelty Co. on practical testing of the pickling solutions. Mr. Sweely gave a method of testing pickling solutions for plant use which requires only a short amount of time and very little labor. After the standard acid solution is made up for pickling purposes it invariably becomes weaker as metal is introduced to be cleaned, and this causes the addition of more acids at various intervals. Therefore some method must be devised by which the strength of the solution may be determined quickly at all times. Mr. Sweely's test consists of testing a small quantity of solution with methyl orange, and if the solution is weak more acid is added.

Karl Turk suggested that hereafter all temperature readings be transferred to the Fahrenheit scale as the practical man is more familiar with this than with the Centigrade scale.

The next meeting of this Section will be held in Washington, December 5, 1925.

LUNCHEON GIVEN BY PACIFIC NORTHWEST SECTION

A luncheon was held on September 25, 1925, in honor of H. G. Schurecht, U. S. Bureau of Standards and National Terra Cotta Society at Seattle, Wash.

Twenty-four members of the Pacific Northwest Local Section met with Mr. Schurecht in the L. C. Smith Building restaurant, Seattle, Washington, for discussion of terra cotta problems. The informal meeting was continued for over three hours, so interesting and valuable were Mr. Schurecht's observations of terra cotta in the wall and experiments in the Bureau of Standards laboratory.

Those present: Hewitt Wilson, Hewitt Fearn, R. Bowman, H. R. Goodrich, Roland Clark, T. E. Nicholson, Donald P. Graham of the University of Washington, C. E. Williams, of the Bureau of Mines, P. S. MacMichael, A. L. Bennett, W. E. Clark, Sam Kinghorn, of the Gladding, McBean and Co. (Northern Clay Co.), Frank and Arthur Houlahan, A. Thompson of the Builders Brick Co., F. A. Carson, Sam Geijsbeek and H. B. McMillen of the Denny Renton Clay and Coal Co., John Stirrat of the Seattle Brick and Tile Co., George McFarlane, of the Seattle Brick and Tile Co., W. J. Howard, P. N. W. Brick Manufacturers Association, D. Thomason, Clayburn Co., Ltd., Clayburn, British Columbia, Albert Armstrong, Dennison Interlocking Tile Corp.

MINUTES OF THE MEETING OF THE JOINT COMMITTEE ON FOUNDRY REFRACTORIES

This meeting was called to order by L. C. Hewitt, Chairman on Coöperation, AMERICAN CERAMIC SOCIETY, at Mellon Institute, Pittsburgh, Pa., 10:30 A.M., September 14, 1925.

Those present were: L. C. Hewitt; M. C. Booze, Senior Fellow, American Refractories Institute; C. E. Bales, Louisville Fire Brick Company; C. N. Ring, Chairman, Refractory Committee, American Foundrymen's Association, Electric Steel Founders' Research Group; Jas. T. MacKenzie, American Cast Iron Pipe Co., Birmingham, Ala.; Mr. Colwell, Division of Simplified Practice, Department of Commerce; Mr.

Corbett, Steel Founders' Society of America; J. L. Cummings, Secretary, Refractory Committee, American Foundrymen's Association.

Letters received from R. F. Geller of the Bureau of Standards and Mr. Morehead of the American Malleable Castings Association were read, expressing their regret at being unable to attend and best wishes for a successful meeting.

Mr. Hewitt explained the formation of the Joint Committee on Foundry Refractories, its aim to standardize on specifications as to sizes, simplification and testing of foundry refractories, for the American Foundrymen's Association including each of the branches of the industry, such as the gray iron, malleable, steel and non-ferrous.

Mr. Hewitt then explained the history of the movement and the results of the Columbus Meeting of the AMERICAN CERAMIC SOCIETY and their agreement to sponsor the movement to standardize on foundry refractories, with the Refractory Committee of the American Foundrymen's Association, and that the meeting now in session was the result of the Columbus Meeting.

As Temporary Chairman of the Committee on Coöperation of the AMERICAN CERAMIC SOCIETY, Mr. Hewitt made the following appointments of this committee to consist of: American Foundrymen's Association (C. N. Ring, R. E. Kennedy, J. L. Cummings); Steel Founders' Society of America (Mr. Colbert); Bureau of Standards (R. F. Geller); American Refractories Institute (M. C. Booze, J. S. McDowell); Bureau of Mines (G. A. Bole); Division of Simplified Practice (Mr. Colwell); American Malleable Castings Association (Mr. Morehead); American Society for Testing Materials (F. A. Harvey); Electric Steel Founders' Research Group (C. N. Ring); Institute of Metals Division of A. I. M. E. (Not yet appointed); AMERICAN CERAMIC SOCIETY (L. C. Hewitt, C. E. Bales); American Electrochemical Society (J. T. MacKenzie).

The election of officers for the Joint Committee was then taken up, the chairmanship going to L. C. Hewitt, upon motion of Mr. Ring, which was duly seconded and carried. Mr. Ring then entered a motion to elect J. L. Cummings Secretary, which was duly seconded and Mr. Cummings, Secretary of The Refractory Committee of the American Foundrymen's Assn., was elected Secretary of the Joint Committee.

Mr. Hewitt then called upon Mr. Ring, Chairman of the Refractory Committee of the American Foundrymen's Assn., for suggestions as to a program to be followed by the Joint Committee. Mr. Ring suggested that committees be formed as follows: Committee on Review of Literature, Committee of Standardization and Simplifications, Committee of Testing and Specifications, and a Committee on a Survey of Conditions of the Branches of the Industry—each of these committees to consist of a maximum of five members and that the Chairman of these committees should be a member of the Joint Committee, and that the Chairman of the various committees name the balance to fill this committee. Whenever possible, each of these committees to contain a technical man, a man from the producers, and a consumer of foundry refractories, which met with the approval of the Joint Committee.

Discussion then followed on the various programs relative to the reason for the failure of foundry refractories, this discussion being led by M. C. Booze. Mr. Booze explained the procedure employed by the A.S.T.M., and the work done to date, covering the principal reasons why refractories fail.

Although tentative, Mr. Booze believes the American Refractories Institute would coöperate with the Joint Committee on Foundry Refractories to secure the proper results of reports, tests, etc. This was tentative due to the fact that the American Refractory Institute had not held their meeting.

The next step resulted in a discussion of a tentative program for the Joint Committee to proceed upon and Mr. Booze suggested that we must have an outline of the work that can be accomplished for the foundry industry, and under what conditions

refractories are used by the foundry industry, what tests would be most practical and a study of failures and of service conditions. This study, with reports, as well as of review of literature on the subject would lead to recommendations being made.

A survey of the various lines of the foundry industry was next discussed together with necessary expense thereto and the American Foundrymen's Association raising the money for the work. Mr. Ring, Chairman of the Refractory Committee of the A.F.A., stated that the proper procedure would be to appoint committees, have them functioning first, gathering all information available, and that with such a program of procedure that the matter of raising sufficient funds for the survey of the foundry industry could be taken up with C. E. Hoyt, Secretary of the American Foundrymen's Association and its officers, and with this program properly outlined could ask the A.F.A. to raise the funds to promote the work of the survey. Mr. Cummings, Secretary of the Refractory Committee of the A.F.A., concurred with Mr. Ring on this procedure.

The next step discussed was the best methods to obtain information for the Joint Committee on Foundry Refractories whether by type of furnace, such as malleable, cupola or open hearth, or by branches of the industry, such as malleable, gray iron, steel, etc. This discussion was led by Mr. Colbert and it was decided to operate by branches of the industry.

Mr. Bole, of the Bureau of Mines, stated that the Bureau had been conducting an investigation relative to refractories for open hearth practice and such information would be available to the Joint committee.

Mr. Colwell, Department of Simplified Practice, Department of Commerce, stated that at the former meetings with the American Foundrymen's Association Refractory Committee, on the work on standardization of the size of sleeves and nozzles, very little progress had been made and that the Bureau would be glad to assist in the work.

The following appointments were then made by Chairman Hewitt on sub-committees:

The Committee on Review of Literature, Mr. Kennedy, appointed with power to select the balance of the members to compose this committee.

The Committee on Standardization and Simplification, Mr. Corbett, of the Steel Founders' Society of America, was appointed Chairman to be assisted by Mr. Colwell of the Department of Simplified Practice of the Department of Commerce with power to name the balance of the committee.

The Committee of Testing and Specifications, M. C. Booze, Chairman.

The Committee on Survey and Conditions of the Branches of the Industry, C. N. Ring, Chairman of the A.F.A. Refractory Committee appointed Chairman.

Various discussions as to refractories used in foundry industry and the standardization of same followed and it was decided best to get the various committees functioning and Mr. Hewitt suggested that names of various men who might be available to serve on the sub-committees and who would be named tentatively for this work.

On the Committee of Survey of Conditions of the Branches of Industry, E. H. Van Schoick, of the Chicago Retort and Fire Brick Co., Jas. Allen, of The International Harvester Co., Mr. MacKenzie and, for the Non-Ferrous section, H. M. St. Johns, of the Detroit Lubricator Company.

On the Committee of Testing and Specifications: R. F. Geller, J. Spotts McDowell, of the Harbison-Walker Company, of Pittsburgh, Pa., Mr. Valentine, of the General Electric Co., of Erie, Pa., and C. E. Bales, of the AMERICAN CERAMIC SOCIETY.

On Committees of Standardization and Simplification: Roy Wetherill, of the Department of Commerce, Utilization of Metals Division.

It was then recommended by Mr. Booze that a member of his Committee of Testing and Specifications, of which he is Chairman, be from the American Refractories

Institute and a suggestion was entertained naming J. M. McKinley, of the Crescent Refractories Co., of Curwensville, Pa., serving on this committee.

Jas. T. MacKenzie was present at this meeting by invitation. Not being a member of the Joint Committee, it was suggested by J. L. Cummings, the Secretary, that an invitation be extended to him by C. E. Hoyt to become a member of the American Foundrymen's Association, Refractory Committee.

After discussion as to procedure and appointments by Chairman of the sub-committees to start same functioning, the meeting was adjourned with invitation to those present to visit the A.F.A. Meeting at Syracuse and take part in a round table discussion, which would be held Tuesday, October 6, in the Dairymen's Bldg., Syracuse State Fair Grounds.

OBITUARY

Samuel A. Weller

Samuel A. Weller, pioneer pottery manufacturer and owner of the Weller potteries, died in Washington, D. C., October 4, 1925, at the age of seventy-four years. Mr. Weller had not had rugged health for several years and he suffered a stroke of paralysis while in Washington which was the immediate cause of his death.

Mr. Weller was born in the little town of Fultonham, Ohio, near Zanesville, and when a young man hardly out of his teens he established a small pottery for the manufacture of flower pots. The accompanying pen sketch[1] will illustrate the primitive cabin built of unhewn logs, his first pottery and the old horse, used to turn the grinding wheel which broke up the clay, going around a muddy circular track pulling a twenty-foot boom attached to the mill. This horse also hauled the crude clay from the clay beds to the factory and after the ware was made the horse was used to haul the ware to the railroad for shipment to the trade. Mr. Weller, himself, not only took active part in the physical processes of manufacture but also traveled around the country selling his ware.

In 1882 he established a warehouse in Zanesville and six years later he moved his factory to the Muskingum River bank. Mr. Weller erected a new plant in 1892 and started the manufacture of jardinieres, hanging baskets, umbrella stands and other articles of pottery and was forced to enlarge his plant again in 1893 and 1894. Almost the entire plant was destroyed by fire in 1895 but Mr. Weller immediately rebuilt and

[1] From an article framed in Mr. Weller's office, 1906.

The illustration here shown is from a drawing made by Sumner Fauly, who was employed in the factory, if it can be dignified by such a name in 1872, and who has been continuously with Mr. Weller ever since.

From this small beginning Mr. Weller's pottery has grown till he now has a factory covering acres in extent, fitted up in the most modern way. From one kiln, crude and inconvenient, he has increased to thirty-five kilns. The improvement in his wares has kept pace with the works until today he has an enviable reputation as a maker of artistic ware.

Through the open door may be seen the hindermost parts of a horse. This horse was old and scrawny, his coat was rough, he was thin and altogether a disreputable-looking beast, but he was worth a lot to Mr. Weller, for besides furnishing the power to grind the clay he served as means of communication with Zanesville which was ten miles away. It is said that Mr. Weller owned a vehicle about as antiquated as the horse, and that when he went into town young Fauly would go with him. Before reaching the more fashionable part of Zanesville, Mr. Weller usually discovered that he had an errand on the outskirts, and would request his "private secretary" to drive to the livery stable. He would then take a horse car for the rest of his journey.

SAMUEL A. WELLER

enlarged the plant. He purchased the Lonhuda Pottery Company of Steubenville, Ohio, in 1896. This pottery established in 1892 was making art pottery with decorations hand-painted under the glaze in Rookwood style. The production of the "Lonhuda" ware was continued and with the addition of the "Louwelsa" and "Sicardo" the ware attained an international reputation. A few years ago, because of his increasing business, Mr. Weller purchased the Sharon Avenue plant of the old American Encaustic Tiling Company and later he added the Zanesville Art Pottery plant to his other plants. Other lines were added and it was not long before the Weller business became one of the leading industries of Zanesville, which position it has held up to the present day.

Weller's old factory

Throughout his fifty-three years in the pottery industry Mr. Weller was the dominating figure in his business. He continued his pottery as an individual business until three years ago when he incorporated the concern. Mr. Weller did not relax his active participation in the work, however, until his death.

Mr. Weller is survived by his wife and two married daughters. A son-in-law, Frederick J. Grant, is treasurer of the Weller Company. Two nephews were also associated with him, Harry Weller, in charge of the manufacturing and Frank Weller, who was personal assistant to Mr. Weller.

NOTES AND NEWS

MEETING OF THE OHIO CERAMIC INDUSTRIES ASSOCIATION

Lord Hall, O. S. U., November 20-21

The second meeting of the Ohio Ceramic Industries Association will be held on Friday and Saturday, November 20 and 21, in Lord Hall, O. S. U., Columbus, Ohio.

The committees of this Association concentrated the past year on establishing a secondary school in ceramics at East Liverpool, the first of its kind. The school started this fall with scheduled classes and equipped laboratories, as a part of high school of that city. Mr. Heusch, director of the State Vocational Board, and the Committee on Education of this Association have started negotiations for a similar school in Zanesville and are planning to extend this scheme of secondary ceramic schools to other ceramic centers in Ohio.

Prof. A. S. Watts, of the Ceramic Department at Ohio State University, is planning a program of University Extension in ceramic education.

Other points of vital interest to ceramic manufacturers are to be discussed in addition to an excellent program of papers.

A block of seats for the Ohio State-Illinois football game has been reserved for the benefit of those attending the meeting.

ACTIVITIES OF THE CZECHOSLOVAKIAN CERAMIC SOCIETY

By Rudolf Barta[1]

Czechoslovakia abounds in ceramic raw materials and is fast becoming the center of ceramic science in Europe. The Czechoslovakian Ceramic Society has about 120 members. These members come from Czechoslovakia, Denmark, France, Germany, Jugoslavia and Poland.

The Society is located in Prague and meetings are held in various cities three times a year. The organization has the following Divisions and Departments:

I. Division for Scientific Research.

Department 1. The Committee for the Founding of a Czechoslovak Ceramic Museum by the Czechoslovak Ceramic Society and the Czechoslovak Technical Museum in Prague.

Department 2. For List and Chart of Ceramic Raw Materials.

II. Division for Standardization.

Department 1, for Analyses of Portland Cement.
Department 2, for Refractory Materials.
Department 3, for Brick Products.
Department 4, for Floor Tile.
Department 5, for Wall Tile.
Department 6, for Stone Ware.
Department 7, for Taking of Standard Kaolin Samples.

III. School Division.

IV. Division for Economy of Heating.

V. Financial Division.

VI. Statistical Division.

Dr. Rudolf Barta

The president of this Society is elected for two years and committee members hold office for the same period. Frantisěk Fischer, a pioneer of scientific ceramics in Czechoslovakia is president. The secretary is nominated by a committee and serves for two years. Rudolf Barta is now general secretary.

Other prominent ceramists of this country are Otaka Kallauner, head man of the Ceramic Institute and professor at the Technical State University in Brno; Karel Hineis, manager of the ceramic works in Rakovnik; Josef Burian, first professor of ceramic sciences at the Polytechnical State University in Prague; G. Kopka, manager of the Fuel Institute for Porcelain in Karlovy Vary; Fr. Kanhaüser, assistant to Dr. Kallauner in Brno; Josef Preller, assistant to Dr. Burian in Prague.

---

[1] Gen. Secy.

This Society issues a publication "Transactions" which contains English abstracts. The meetings held this year are as follows:

1. Prague, March 28, 1925.
   Lectures: (1) "Losses in the Brick Industry and the Possibility of Preventing Them," by A. Rezáč; (2) "Cement from Rotary and Shaft Kilns," by Josef Zitný; (3) "On Action of Scoring on Refractory Products," by Voclav Korber; (4) "On the Aceh Ceramic Terminology," by Josef Matejka.
2. Karlovy Vary, June 12 and 13, 1925.
   Lectures: (1) "The Tunnel Ovens in the Ceramic Industries," by V. Pohl; (2) "New Research in the Institute of Silicates in Brno," by O. Kallauner; (3) "Testing of Insulation," by J. Kopka.

MEETING OF AMERICAN REFRACTORIES INSTITUTE[1]

The meeting and the banquet of the American Refractories Institute will be held at the Waldorf-Astoria Hotel beginning at 10:00 A.M. October 29. The morning session will be opened with an address by W. C. Sproul, President, and then given over to a business meeting, reports of committees, etc. Following this a buffet luncheon will be served in a private dining room adjoining the room in which the meeting will be held. In the afternoon talks and papers will be given as follows:

"The American Refractories Institute," by J. D. Ramsay, Elk Fire Brick Co.; "Fire Brick Specifications," by J. Spotts McDowell, Harbison-Walker Refractories Co.; "Work of the Refractories Fellowship at Mellon Institute," by M. C. Booze; "Service Conditions in Boiler Furnaces," by Ralph A. Sherman, U. S. Bureau of Mines; "Shrinkage of Diaspore," by S. M. Phelps, Mellon Institute; "Organic Bonds for Silica Brick," by M. C. Booze, Mellon Institute.

A banquet, which is to be a stag affair, will be served at 7:00 in the evening. The speakers for this include Senator George Wharton Pepper, Elisha Lee, Vice-President of the Pennsylvania Railroad Company, and General T. Coleman du Pont. It is probable that Charles M. Schwab will also be present and talk on one of his favorite topics.

ST. LOUIS DISTRICT ENAMELERS' CLUB

Report of Meeting, September 29

Nineteen members were present at the meeting of the St. Louis District Enamelers' Club held on Sept. 29, at the American Annex Hotel, St. Louis.

W. V. Knowles of the Titanium Alloy Mfg. Company and member of the AMERICAN CERAMIC SOCIETY was a guest. Mr. Knowles gave a talk on various compounds and enameling. The chief address of the evening was presented by J. P. Wentworth of Beacon Factories, Inc., on "Your Value to Your Organization." Other speakers were J. P. Cole, J. B. Ford Company, who talked on "The Use of Cleaning Compounds," and Fred Janson, Wrought Iron Range Company, whose subject was "Ground Coat Burning on Steel."

[1] Advance announcement received Oct. 16, 1925. M. C. Booze, Acting Secretary.

EASTERN POTTERY MANUFACTURERS INVESTIGATE FELDSPAR PROPERTIES IN SOUTH[1]

The importance of the ceramic raw materials of the south is becoming more apparent every day. More and more of the northern and eastern pottery producers are investigating the various sources of feldspar, kaolin, ball and sagger clays and flint than ever before. This is especially true of the feldspar deposits.

Recently the following pottery manufacturers from the Trenton, New Jersey, district were guests of the Erwin Feldspar Company of Sprucepine, N. C., and Erwin, Tennessee, at which time a careful inspection of the mines and mills of the Erwin Company were made.

The party included Mr. and Mrs. Leslie Brown of Lenox Incorporated; Mr. and Mrs. J. M. Gilfillan of the Trumbull Electric Manufacturing Company; Andrew Foltz, President, Lambertville Pottery Company, Lambertville, New Jersey; John F. Hutchins, Manager, B. O. T. Manufacturing Company; Oscar Van Fleet, President, Van Pottery Company; Enoch Muntford, Manager, Anchor Pottery Company; George Martin, Manager, Keystone Pottery Company; C. H. Chamberlain, Manager, Bay Ridge Specialty Company; Prof. George H. Brown, Director of Ceramics, Rutgers University, New Brunswick, New Jersey; and Prof. A. V. Henry, Director of Ceramics, Georgia School of Technology, Atlanta, Georgia.

When the party arrived in Johnson City, Tennessee, from the east they left immediately in a special car attached to a regular train on the Clinchfield Railroad, for Sprucepine, N. C. Near Sprucepine the visitors were met by R. W. Lawson, President of the Erwin Feldspar Company and were taken to the mines on Crabtree Creek in a special car over the private railroad operated by the Erwin Company.

After making an inspection of the mines the party was taken to the hotel at Sprucepine at which place a banquet was tendered them. S. T. Henry of New York and Sprucepine extended a cordial welcome to the visitors and told them of the remarkable growth of western North Carolina and pointed out the many advantages of that section for industrial development. L. H. Phetteplace, General Manager of the Clinchfield Railroad reviewed in a most interesting way the industrial development in the territory traversed by the Clinchfield Railroad. Mr. Phetteplace predicts a much greater development during the next ten years and pointed out the advantages of this location for ceramic industries. Dr. Charles Peterson of Sprucepine, a local physician, told of the climatic advantages of western North Carolina and the desirability of this section from the standpoint of health. Mr. Smith, Manager of The Harris Clay Company, of Sprucepine, explained the method of mining and refining North Carolina kaolin.

On behalf of the guests, Leslie Brown, Andrew Foltz, George H. Brown and A. V. Henry responded in a most delightful manner. Mr. Brown told of his experiments with the use of North Carolina feldspar which have proven successful in the production of extremely high grade china. Messrs. Foltz and George H. Brown pointed out the necessity of keeping feldspar uniform and told in clear terms the requirements of the various manufacturers so far as feldspar is concerned. Prof. Henry reviewed his work at Georgia Tech. and explained in detail the ceramic raw materials of the southeast. He, too, predicted a rapid growth of the pottery and glass industry in the south. V. V. Kelsey, of the Erwin Feldspar Company, acted as toast master.

The visitors expressed surprise and interest in the great extent of the feldspar deposits in western North Carolina.

The following day the party made an inspection of the English Knob mines of the Erwin Company and returned to Erwin, Tennessee, where they visited the mills of the

[1] By V. V. Kelsey, Erwin, Tenn.

Company and were later guests of the Southern Potteries, Incorporated, of Erwin. They left for the east on Sunday night.

Prior to 1911 there was no feldspar being produced in North Carolina on a commercial scale. Today this territory is producing half the total amount of feldspar consumed by the various ceramic industries of this country. The industry has grown from a modest start in 1911 to its present size which argues well for the quality of this material from North Carolina.

During 1924 a total of 96,000 long tons of feldspar were mined in North Carolina which was more than the entire country consumed in 1921. This is a remarkable increase in three years. The production in 1924 represented an increase of 68% as compared with 1923.

CALENDAR OF CONVENTIONS

Organization	Date	Place
Amer. Assn. for Advancement of Science	Dec. 28–Jan. 2	Kansas City, Mo.
AMERICAN CERAMIC SOCIETY	Feb. 8–13, 1926	Atlanta, Ga.
American Chemical Society		
(Spring Meeting)	April 5–9, 1926	Tulsa, Okla.
American Concrete Institute	Feb. 23–26, 1926	Chicago, Ill.
Amer. Electrochemical Society	April 22–24, 1926	Chicago, Ill.
American Engineering Council	January, 1926	
American Face Brick Association	Dec. 1–3, 1925	Atlanta, Ga.
Amer. Institute of Chem. Engrs.	Dec. 2–5, 1925	Cincinnati, Ohio
Amer. Institute of Min. and Met. Engrs.	February 15, 1926	New York City
Amer. Iron and Steel Institute		
American Mining Congress		
(Annual Meeting)	Dec. 9–11, 1925	Washington, D. C.
(Western Division)	Nov. 16–19, 1925	Chandler, Ariz.
Amer. Soc. Mechanical Engrs.	Nov. 30–Dec. 3, 1925	New York City
Amer. Soc. Steel Treating	Jan. 21–22, 1926	Buffalo, N. Y.
Amer. Soc. Testing Materials	June 21–26, 1926	Atlantic City, N. J.
Amer. Zinc Institute	April 27–28, 1926	St. Louis, Mo.
Assn. Chemical Equipment Mfrs.	May 10–15, 1926	Cleveland, Ohio
Assn. Iron and Steel Mfrs.	May 31–June 5, 1926	Chicago, Ill.
Associated Tile Manufacturers	December 9, 1925	New York City
Baltimore-Washington Section		
(American Ceramic Society)	Dec. 5, 1925	Washington, D. C.
Coal Mining Institute of America	Dec. 9–11, 1925	Pittsburgh, Pa.
Common Brick Manufacturers	February 22–26, 1926	Atlanta, Ga.
Grinding Wheel Mfrs. of U. S.		
and Canada	Dec. 11, 1925	Buffalo, N. Y.
Hollow Building Tile Assn.	January, 1926	Chicago, Ill.
Manufacturing Chemists' Association	May or June, 1926	Near New York City
Natl. Acad. of Sciences	Nov. 9–11, 1925	Madison, Wis.
(Spring Meeting)	April 26–28, 1926	Washington, D. C.
Natl. Assn. of Mfrs. of Pressed and Blown		
Glassware	March 9, 1926	Pittsburgh, Pa.
Natl. Assn. Stove Mfrs.	May 12–13, 1926	New York City
Natl. Brick Mfrs. Assn.	Nov. 2–7, 1925	St. Louis, Mo.

Organization	Date	Place
Natl. Exposition of Coal Mining Mach.	Dec. 2–5, 1925	Cincinnati, Ohio
Natl. Exposition of Power and Mechanical Engrs.	Nov. 30–Dec. 5, 1925	New York City
Natl. Glass Distributors Assn.	Nov. 10–11, 1925	New York City
Natl. Paving Brick Mfrs. Assn.	January, 1926	
Natl. Society Vocational Education	Dec. 3–5, 1925	Cleveland, Ohio
Natl. Terra Cotta Society	Nov. 13–14, 1925	Washington, D. C.
Natural Gas Assn. of America	May 17–20, 1926	Tulsa, Okla.
New Jersey Clayworkers' Assn.	Dec. 18, 1925	New Brunswick, N. J.
Ohio Ceramic Industries Assn.	Nov. 20–21, 1925	Columbus, Ohio
Sand-Lime Brick Assn.	Feb. 9–15, 1926	New Orleans, La.
Taylor Society	Dec. 3–5, 1925 1925	New York City

BULLETIN

of the

American Ceramic Society

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

Vol. 4 — December, 1925 — No. 12

EDITORIALS

ALLOCATION OF CERAMIC WORK IN FEDERAL BUREAUS

All who have given thought to the many points involved in the general question of allocation of ceramic work between the Bureau of Standards and Bureau of Mines realize that what the bureaus need most is concerted support and coöperation of all the ceramic industries. The allocation details are matters of policy and laboratory direction for which the Department of Commerce is responsible and wholly capable to conduct. Secretary Hoover wants from ceramic manufacturers an organization qualified to advise on character of work to be undertaken and on means of securing the most extensive collaboration of the state and industrial investigation laboratories.

Plant proving of laboratory results has been endorsed because it is practical and conclusive. Results of plant investigations which have been proved should be wholly public property. Special advantages to the plants where the proving is done or to the firms who help finance the work are no more than those involved in "first hand experience." Patent rights on all new disclosures should be assigned to the public, and a minimum of time allowed between the finding of the information and making it known to the public.

The government laboratories should devote most of their resources to fundamental investigations but these investigations should be only such

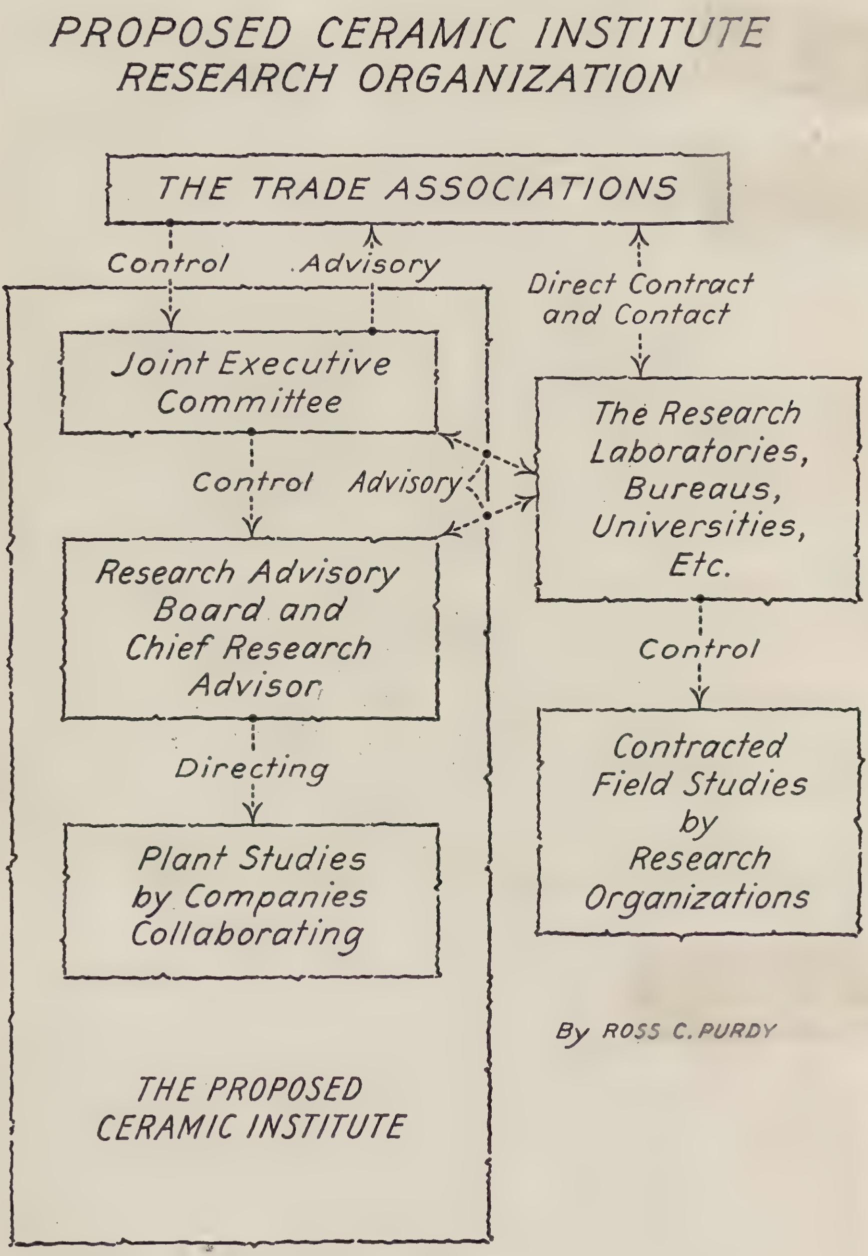

PROPOSED CERAMIC INSTITUTE
RESEARCH ORGANIZATION
THE TRADE ASSOCIATIONS
Control
Advisory
Direct Contract and Contact
Joint Executive Committee
Control
Advisory
The Research Laboratories, Bureaus, Universities, Etc.
Research Advisory Board and Chief Research Advisor
Control
Directing
Contracted Field Studies by Research Organizations
Plant Studies by Companies Collaborating
By ROSS C. PURDY
THE PROPOSED CERAMIC INSTITUTE

Fig. 1.

as are of immediate importance. All work on fundamentals is twofold, abstract and applied. There are enough problems of current need for which fundamental data are lacking that the federal bureau could well adopt as a working principle that all investigations should be carried through to proof under plant conditions.

The bureaus need a strong unit contact with the manufacturers in all ceramic investigation. The manufacturers should so organize as to make sure and readily available a strong working contact. All heavy clay products manufacturers would be placing themselves in position to give and to receive aid in federal researches if they would function through the Clay Products Institute. The whiteware manufacturers should organize a similar institute. Whether the trade associations having the same major problems will coöperate collectively through institutes or singly as trade associations, we are convinced that the means of collaboration diagrammed in the organization chart here shown will give the most flexible and yet the most positive and frictionless unit contact for the government.

As to allocation of ceramic work it will have to be admitted that for as long as the Bureau of Mines operates for the beneficiation of minerals, metallic and non-metallic, they will have to study fuel and metallurgical economies in which refractories have an important part. The Bureau of Mines will have to continue working in that borderland where the ceramic engineers, fuel engineers and metallurgical engineers have a great deal in common. If the ceramic work of Bureau of Mines was restricted to refractories for power and metallurgical purposes they would have a large burden. It would be well if they were so restricted.

The Bureau of Standards should do plant proving by sending men into the field. Plant proving involves considerable laboratory investigating and for this a station should be maintained. Quite naturally the geographic place for such a station is the industrial center of both ceramic producers and consumers. The Government has such a station in Columbus. Economies in operation from standpoint of the Government and the industries alike make evident that this Columbus station should be continued.

Also, the several state universities have extensive laboratory space, equipment and qualified research personnel with which the federal government and the industries should be coöperating. The largest and most far reaching consideration in this general question of allocation of ceramic work under federal and state auspices is in the economic employment of the facilities of the several state universities.

With a representative research advisory board as provided for in the scheme suggested in Fig. 1, the federal bureau would have the very broadest and best informed council and the industries would have the

benefit of the most economical employment of the country's research facilities. Economy, flexibility and best informed advisory service to the government and to the industries is made possible by the scheme here presented.

A LETTER FROM AN ACTIVE MEMBER

Why am I a member of the American Ceramic Society? Is it only to receive the monthly *Journal* and the other publications of the Society? I admit that these are worth more than the ten dollars annual dues, for in them are results of researches and operating schemes which represent a great many times $10.00 in original cost and many times $10.00 in value to me. Nowhere else can I find so complete an abstract of the world's ceramic literature. I realize that every cent over the office and postal expenses which the 2000 members pay as dues is put into the *Journal*, bibliographies and book lists. I know that the profit from these publications which comes directly from the information recorded, cataloged and transmitted equals several times the cash I give in exchange.

Though worth more than it costs, the *Journal* is not my fundamental reason for membership in the Society. The *Journal* is no more than a record of the results and not the cause of them. It is one of the essentials to the real purpose of the Society. Collaboration of the scientific, technical and artistic ceramists in promoting agencies for research and education for collecting and distributing information is the real purpose of the Society.

When I consider the profound change that has been made in the character of reading matter in the trade journals; when I contrast the present unfilled demand for men trained in ceramic schools with the very sparse opportunities for the school-trained men fifteen years ago; when I see trade associations placing high value on scientific and technical research; when I recall that the ceramic divisions in the federal bureaus were in response to petitions by this Society and when I learn that in every nation where the ceramic industries have developed there is a national organization like our American Ceramic Society, I feel proud that I have had a part in the work done by the members through the Society. I am sure that technical progress in ceramics in America has been possible because the scientific, technical and artistic ceramists have been working together, sharing information and exchanging experiences in an organized way. This is the reason I am a member of the American Ceramic Society.

PAPERS AND DISCUSSIONS

SILLIMANITE REFRACTORIES

By A. Malinovszky

The papers of Hewitt Wilson[1] and T. S. Curtis[2] which were read at the Summer Meeting of the American Ceramic Society at Los Angeles, California in regard to the fused sillimanite refractories were very interesting. As these researches were conducted only on electrically fused sillimanite ingots, I should like to know what percentage of glass has been found surrounding the crystals.

I have produced purer sillimanite crystals with much lower glass by the Bessemer method than with the electric furnace. The sillimanite crystals made in the electric furnace were not more than 75% or the highest 88% pure sillimanite. The rest was a glass which contained from 2% to 3% of $Na_2O + K_2O$ and from 1% to 2% of $CaO + MgO$.

Fig. 1.—The crystals as they occur in parallel blades. The ground glass which forms the base for the sillimanite crystals is made up of felty aggregates of very fine needles crossing every angle.

Prof. Salisbury who made the first petrographic examination in 1910 of the electrically fused sillimanite ingot called my attention to the fact that to produce pure sillimanite crystals I would have to first get rid of the alkalis before the crystallization process commences or use a purer material and coke.

Therefore, early in 1911 I had begun to experiment with the Bessemer method. This proved to be more satisfactory than the electric furnace.

With the Bessemer process I was able to eliminate the alkalis and I have produced a product of 95% pure sillimanite with only 5% of a ground glass free from the alkalis.

The Bessemer process gave a product which analyzed as high as 81% of Al_2O_3, especially those which were fused from diaspore or bauxite.

[1] H. Wilson, C. E. Sims and F. W. Schroeder, "Artificial Sillimanite as a Refractory," *Jour. Amer. Ceram. Soc.*, **7** [11], 842; [12], 907 (1924).

[2] T. S. Curtis, "Synthetic Sillimanite in Ceramic Bodies," *Jour. Amer. Ceram. Soc.*, **8** [1], 63–8(1925).

Professors Salisbury and Johannsen and also A. A. Klein and W. H. Tomlinson found corundum present ranging in the various samples from very small percentage up to as high as 16%. The higher the corundum the greater was the resistance to spalling, corrosion, load and high temperatures. Many samples of the sillimanite thus produced were more refractory than cone 42.

FIG. 2.—Enlarged about twenty diameters.

Of the three microphotos shown here, Fig. 1 contains 95% of sillimanite and 5% of a mixture of brown and clear glass. Figures 2 and 3 contain 90% of sillimanite and 10% of a mixture of brown, green and grayish white glass masses.

Figures 1 and 2 are sections parallel the fibers and Fig. 3, cross-section of the same ingot as Fig. 2.

In cross-section the sillimanite crystals are rather uniform in size ranging from .02 to .03 inch. It can be seen that these crystals are not solid but have a skeleton growth away from the centers toward the corners. In length the longest fiber measures over .35 inch and this was broken off at both ends. It is likely that many of the fibers are one inch or more in length.

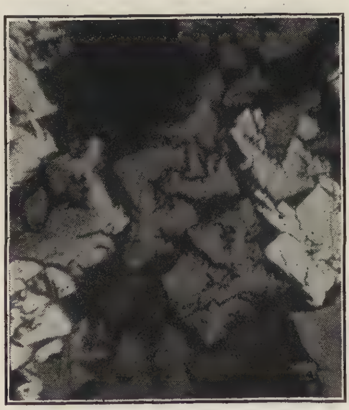


FIG. 3.—Cross-section enlarged about twenty diameters.

There is no reason to suppose that the cost of super-refractories of sillimanite will prohibit its use commercially. At the Washington Iron Works a U. S. Rotary Smelter was lined with a sillimanite refractory a year ago and up to March this year has made 2416 smelts. First we smelted enamel and now we are smelting ground coat.

We lined the stationary smelters one year ago and in one have made 1600 smelts. It is still good for many more. In the other smelter we made only 600 smelts when we had to repair it. In the smelter which made only 600 smelts the brick perhaps contained a high percentage of glass high in alkalis which reduced its resistance to corrosion and spalling.

WASHINGTON IRON WORKS
LOS ANGELES, CALIF.

CHINA CLAY[1]

By Stephen Leech

In the course of contact with my fellow ceramists and others I have been struck by the lack of a precise understanding as to what china clay is, is not, and may be, more especially as to what constitutes the difference between the "imported" and the "domestic" (or as I should prefer to call it, the "native") china clay.

There is a fundamental difference between the two.

Broadly speaking, the "imported" or English china clay is the result of the kaolinization by pneumatolytic action on the feldspar of granite, the altered product remaining *in situ* until the moment of its artificial separation from the other elements of the granite (these remaining unaltered). The domestic or native china clays are the result of subatmospheric decomposition of rocks, chiefly of the gneissic order, at the surface, their kaolinitic matter being separated by aqueous influences, carried and redeposited elsewhere.

The effect physically and, possibly, chemically of these varying conditions is a matter well worthy of consideration. So far as I know there is no evidence of pneumatolytic action ever having taken place in this country, and although I do not regard the evidence on the point as being complete, I think it may be taken for granted that the native clays are the outcome of trituration and redeposition alone.

Our Earth

We have, therefore, first of all to take into consideration the English clays, in their primary form as part of granite.

If we were to get below what one of the jesters in chemistry has thought well to call the "half-mile crust" of the earth we should find that the crust is getting (or remaining) softer and softer, more inchoate, until it finally passes into the semi-liquid state called "magma." Nearer still to the earth's center we should probably find this magma, which comes to our minds as a substance of the consistency of molasses, becoming still more thinly liquid and finally passing into vapor and then into gas alone. We are concerned only with the magmatic condition. In this, partly by reason of physical and chemical affinities, are formed segregations of matter of different constitutions. They are probably irregularly disposed. One of these is the granite magma, that is, it is a magma containing silica, alumina, alkali or alkalis and some metallic elements in such proportions that if ejected to the surface the magma would cool as granite.

The older portion of the crust of the earth, as it cooled, contracted—forming cracks and fissures all over its surface. The detached portions

[1] Recd. January, 1925.

so formed sank and tilted at irregular angles, receding into the unsolidified magma below with a double effect—that of forming what are called "faults" (more or less vertical fissures) and of squeezing out through such fissures the underlying magma to the surface. Here the magma cooled. Its excess of silica crystallized out as quartz, its combined silica and alumina and alkalis as feldspar, its minor metallic elements as mica—chiefly muscovite and biotite, with some little hornblende. Thus the cooled magma became granite—a mosaic of crystals of quartz, feldspar and hornblende with here and there films and detached flaky crystals of mica.

Floating in the molasses-like mass of the magma were what are called phenocrysts, that is, crystals of feldspar, of varying size. The reason for the formation of these in the magma before ejection is a matter of rather deep inquiry. Suffice it to say that it is usually attributed to supersaturation of the magma with the element silica. The presence of the phenocrysts is a matter of some importance as we shall see later. Together with the more liquid portions of the magma they were ejected to the surface, floating along like chips of wood in a stream. The magma spread in sheets and masses, often infiltrating the joint-planes of the measures through which it passed, but in the main it formed hills and mounds above the higher levels of faulted measures at the surface.

Subsequently, owing to the shifting or the exhausting of the magma, gases followed on along the same lines of weakness. These gases consisted largely of boron and fluorine, the former picking up the iron and certain other elements and forming schorl-tourmaline, the fluorine robbing the feldspar of its silica and rendering its alkalis soluble. It is in this condition that we find the mineral called china clay rock from which the china clay is derived.

Devon and Cornwall, England

This sequence of geological and mineralogical occurrences took place only within a very limited area in England, entirely in the southwestern part of the country, in the counties of Devon and Cornwall. There is practically no production of china clay in the British Islands outside these areas. The productive capacity of areas themselves differs considerably, the extent and thoroughness of the kaolinization varying. The St. Austell area is by far the best. The area takes its name from that of the pleasant little town on its southern coastal border. The town in turn borrowed it from that of its protecting saint, St. Austin or Augustin. From the town northward the country rises steadily until reaching a height of over 1000 feet above sea-level at Hensbarrow Downs, some six miles from St. Austell, and this point may be considered as the center of the china clay activity.

The St. Austell area as a whole—that is the area in which granite,

kaolinized or unkaolinized, is at the surface—falls into a shape which may well be likened to that of half of a large pear, the flat side downward.

Its shape and contour, which is to be taken as the plan-line of the granite where it clears the county rock or "killas" as it is called (and which killas measures are the Meadfoot Shales of the Middle Devonian formation), includes both kaolinized and unkaolinized areas. These are sharply separated by a line of fault called the luxulyan fault. The kaolinized portion lies to the west of this fault and the unkaolinized portion to the east.

The shape and the occurrence of the high points, afford data for interesting speculation. The flow of phenocrysts follows closely the center line, on both sides the luxulyan fault. The granite nearer the edge of the mass is finer in texture, indeed approaches that of micrograrnite. Again, the minor faults or fissures, which by the way carry tin wolfram and copper ores, are ranged on the flanks of the pear-shaped mass approximating to its course or are distinctly at right angles to it. These fissures are precisely where one would expect a mass of that shape to crack on cooling. There is little room for doubt therefore that the St. Austell mass of granite is of the order of things known as a laccolith, that is, there is probably a deep-seated neck somewhere from which the whole mass spreads eastward. The depth or thickness of the mass is difficult of estimation but it is probable that the mass rests on the upper surface of the next formation succeeding downward, the Devonian, *viz:* the Silurian, but as the lower measures of the Devonian do not outcrop in the district their thickness cannot be estimated with any certainty.

There was, it may therefore be assumed, a mass of granite having a central core or backbone of phenocrystine or, as it is called, porphyritic granite dating from a core or neck somewhat to the south of the eastern end of the mass.

From such a point would flow the last of the magma, to be succeeded by gases and vapors. That such was the case is evidenced by the fact that at or near the point indicated occurs the variety of the St. Austell granite known as Cornish or china stone. This "stone" differs from the general mass of the granite in several important respects. One of the most important is that it shows the invasion of fluorine. Its quartz becomes of a purple tint and it carries topaz grains, topaz being a fluoride of alumina. The topaz occasionally appears as a separate mass and in such cases is usually accompanied by much schorl-tourmaline. The latter is a borosilicate and, therefore, indicates and justifies the view previously expressed that the subsequent kaolinization of the granite, or rather of the feldspar of the granite, was effected by the action of fluorine in the presence of boron. The beneficent effect of the latter was to carry the iron of the rock present originally as biotite into the insoluble

of the borosilicate. It is only reasonable to admit that there is some contention as to the precise nature and sequence of the processes by which the kaolinization of the feldspar has come about. There are not wanting those who contend that the process has been from the surface downward; and other most ingenious theories have been advanced. The pneumatolytic theory is, however, the one most generally accepted and to it the writer, who has had the advantage of living on the spot for several years, gives his unqualified adherence.

The principal points of evidence in its favor are:

(1) The fact that the kaolinization never appears at the surface. There is always a layer of disintegrated but not kaolinized granite from the surface downward. This layer of material, which is locally called "growan" may be from four to fourteen feet thick. In it, all the elements of the granite are present. It ends off abruptly. In sinking through it, practically one spadeful is in the "growan" and the next in the fully kaolinized china clay rock. This is of itself strong presumptive evidence of rising, heated gases ending their influence at a definite point of cooling.

(2) The deeper the pits are sunk in the kaolinized rock the more complete, absolute and unvarying does the kaolinization become. Pits have been sunk to a depth of 300 feet with the result that the deeper the sinking is the better the clay.

(3) In some cases the overlying killas measures are also kaolinized and always from contact with the erstwhile granite upward, never from the surface downward.

(4) The area of kaolinization is sharply divided by the luxulyan fault.

Practically no kaolinization extends to the east of it. Gases permeating the granite mass from the west eastward would find in the broken and ill-filled fissures of the fault abundant outlets. Their efficiency ended there. It is certain that had the influence been a superficial one it would have affected the granite equally on both sides the line of faulting. That there was a very free escape of boron at this point is evidenced by the densely studded rock called luxulyanite from a single block, or rather boulder, of which the sarcophagus enclosing the remains of the Duke of Wellington was made. The beauty of this rock lays in the stellate clusters of tourmaline with which it is packed, and the tourmaline, as we have noted before, is the borosilicate of iron, magnesia and alumina.

Those who are so far interested in the contra-theories as to kaolinization will find the whole subject traversed in the very excellent book on china clay and china stone written by Allan Howe of the English Geological Survey. The writer wishes to take advantage of this allusion to acknowledge his own indebtedness to that work, which treats exhaustively the subject of china clay not only in England but in all countries of the world.

English China Clay

The china clay rock as it lays in the earth or near its surface is of the consistency of half-set concrete. It is hygroscopic, that is to say it takes up and retains much water. It is very rare to find it in dry condition. This is fortunate, as most of the pits working on it are on the tops of hills or along ridges on the sides of bare, bald, treeless hills, and water plays a most important part in the separation of the actual china clay from the quartz, mica and schorl-tourmaline which accompany it.

The methods by which the actual china clay, the now kaolinized feldspar, is separated from the quartz and other waste matter have been so frequently described and illustrated that it is not necessary for the present writer to more than summarize them. They have especially been set forth in all detail in the work before referred to, Allan Howe's book, and it is to be regretted that certain recent dissertations on the subject, which are almost word-for-word repetitions of the matter of that book have appeared in the columns of a contemporary without the acknowledgment that was their due.

Anywhere westward of the luxulyan fault there is little difficulty in finding an area to yield china clay. Of course care has to be exercised, especially on the subject of water supply, and, naturally, as to means of communication with road and rail. A site being selected and "proved" by the sinking of trial pits, a pumping shaft is sunk at some little distance from what is expected will become the center of the pit. This shaft is followed by an *adit* or level driven from the bottom of the pumping shaft to the center of the pit and then by an upcast shaft; the level is connected with the surface of the pit. The surface is then stripped of the overlying "burden," generally the growan before described and a foot or two of poor upland soil. The overburden is always kept well back from the edge of the pit and a deep trench sunk to receive percolating surface water and prevent its entering the actual pit. As the actual pit increases in size it is most important that this keeping back of the overburden is well attended to. It is a heavy "cost" on the china clay obtained, especially in the early stages of opening of a pit of work, and neglect of it is often the cause of much of the discoloration in the china clay as we receive it. Water must now be conveyed in trenches or "launders" to the edge of the actual pit and there allowed to run over and down the sides of the excavation. This has the effect of breaking down the softish rock, assisted by manual operations, the water pouring down into the pit below a puddly mass of "sand" (as all but the actual clay is called) and clay water.

It flows toward the center to the top of the upcast shaft, but it is intercepted in its course by the "sand boxes," a simple but ingenious contrivance by which the stream is allowed to precipitate the coarsest of its sand. The clay water enters and fills the upcast shaft and level. At

the pumping shaft it is brought to the surface, a suspension of 10% to 15% clay together with all the finer sand and all the mica.

The greatest difficulty the clay worker has is to get rid of the mica. By passing the suspension successively through smaller pits and finally in a slowly moving stream over broad areas of slightly inclined surface, called "mica-drags," the whole of the undesirable matter is precipitated, but not without serious loss of clay as well. The purified suspension is received in settling pits where, after considerable time, the clay settles and the excess water is decanted off and reused; the now creamy suspension is passed on to the "tanks" where a much longer period of time is allowed for it to further settle and solidify about to the consistency of the familiar substance—lard.

In this condition it is conveyed to and deposited on the "drys" or drying floors, large areas of porous tile overlying heating flues. The clay is spread in a layer 6 to 10 inches thick, "nicked-up" as it dries, and so leaves the floor in the roughly cuboidal chunks so familiar to us on receipt of our supply of "imported clay." It is never dried to "bone dryness" inasmuch as, being hygroscopic, it would again pick up from the atmosphere 10% to $12^1/_2$% of moisture. We, therefore, all buy it well knowing we are buying that minimum amount of water.

All these arrangements sound very simple—almost primitive. So they are, but they are effective, and with the exception of the waste of clay or its reduction to second and third qualities known as "micaclays," there is little room for improvement upon them from an economical point of view. As compared with the "sandwheel" methods employed on the clays of this county they are far more effective in getting rid of deleterious matter.

Little has been done in England to substitute mechanical treatment for the older method of levigation and precipitation pure and simple. A fairly common practice is the acidulation of the water in the banks to facilitate precipitation. On the other hand an attempt has been made by increasing the viscosity of the bank water by the addition of sodium silicate to retain the finer particles of clay in suspension longer and so, by separate decantation and filter-pressing of the upper suspension, to obtain a finer grade of clay for special purposes. The most radical improvements which have been made in the process have been the substitution of forcibly ejected streams of water from hose-nozzles directed against the face of clay-rock in place of the natural run of the conducted stream down its face, which newer method is known as "hydraulicking," and the introduction of the pipe-line system. Many of the older works were situated back in the hills, the transfer of the finished clay to rail or port involving miles of heavy haulage over difficult roads. As fortunately, the average gradient is toward the coast it has been possible to establish systems of pipe-lines, the ordinary 9- or 12-inch sewer pipe of this country,

conveying the suspension at the point at which it would ordinarily pass to the settling tanks on the "work" to tanks and "drys" located at points on the railways or at ports eight to ten miles distant from the actual clay pits. Thus a double saving has been effected, the cost of hauling fuel for drying to the works and that of hauling the dried clay to loading stations.

The only really revolutionary method introduced to the trade within the writer's knowledge was passing the whole of the clay-rock through rotary washers and the effluent treated in a series of centrifugal separators culminating in the "Gee" separator. This was followed by an equally rapid system of drying in a progressive tunnel-drier. It was possible for the clay mined in the early part of the day to be loaded the same day as finished clay. The prime object, however, was to obtain clay of far finer texture than the ordinary for use in certain industries under the exigencies of war-time conditions.

It is generally conceded that English china clay represents an aggregation of crystals of the mineral, kaolinite. Such crystals are sub-microscopic but their structure and habit is known. They are flat, hexagonal or rhomboidal forms, of a thinness so extreme as to be barely comprehensible in figures. Their habit is to form, by superimposition, masses or groups, still so minute as to be only just within the possibility of detection under the highest-powered microscope, of dendritic or branching growths or in piles and strings known as "rouleaux" or "vermiculae." This initial fact is important to the user. The plasticity of china clay, often annoyingly limited, can be considerably enhanced by protracted grinding which has the effect of breaking down the aggregates and increasing vastly the area of surface tension.

We have in such china clay a substance of quite uniform chemical constitution. We can, therefore, rely upon its presenting a uniform degree of refractoriness, in other words of its being pretty constant in point of shrinkage and freedom from fire influences calculated to produce warping. Such measure of uncertainty as there may be between one grade of imported china clay and another is due rather to the degree of thoroughness with which the elimination of the mica (in particular) has or has not been carried out. That, in plain words, means that the best clay is produced by the firms having the largest mica-drag areas.

The pneumatolytic action which locked up the original iron of the granite by converting the biotite schorl-tourmaline thereby gave us a practically iron-free material, for the schorl is the one substance which, thanks to its high specific gravity, is most easily gotten rid of in the sedimentation processes. In addition, if the clay has been produced in the areas in which the primary granite was of the porphyritic or phenocrystine order the relative proportions of both mica and tourmaline were low, therefore good color is assured.

A MONEY SAVING RECORD SYSTEM FOR CASTING SHOPS[1]

By L. L. Beeken

Some sort of systematic factory record keeping is necessary in every ceramic manufacturing plant. Factory records are an essential part of any cost accounting system and they are an equally vital element of an exact and complete technical or process data history.

It is most important that such records be not laboriously obtained, complicated or too costly—"the tail must not wag the dog."

The record system used at the Jeffery-Dewitt Insulator Company has been evolved to cover their particular conditions.

Operation of the whole record system requires the employment of (1) a timekeeper who is also a superintendent clerk; (2) a bookkeeper who does all costing and also keeps all the rest of the Company's accounts; (3) foremen and certain factory operators to do a small amount of clerical work each day; (4) the operation of a factory storeroom and its attendant.

MAINTENANCE LABOR

At Dept...................................

Charge No...................Date...........

Job.......................................

....

Hours........Rate........Amount...........

O. K. .... Employee

.... Dept. Foreman   Clock No.............

The system supplies the cost accounts with (1) all production counts; (2) all time or labor charges; (3) all material charges; (4) overhead or burden distribution; (5) inventories of raw materials, work in process and stock. At the same time it gives

DAILY TIME REPORT

Date......2/9..........................1925

Name............Allen Keffer..............   Clock No.........165.......................

Account	Lot No.	No. Hours or Pieces	Rate	
1302		4½	.70	$3.15
801		1		.70
708		2½		1.75
Total				

O. K.......V. P. Mengle................. Foreman   Recorded .... Time Book

Approved................................ Supt.   .... Cost Record

[1] Presented at the Annual Meeting, American Ceramic Society, Columbus, Ohio, Feb., 1925. (White Wares Division.)

us rather complete technical and process data upon each lot of each type of product; and does this systematically and automatically.

Three main classes of records are involved, namely (1) time or labor charges; (2) material requisitions; (3) lot production records.

Time or Labor Charges

The factory time or labor charge slips are similar to those in common use. Each workman daily charges his hours (or piece work) to the account worked upon. This is approved by the foreman and sent to the timekeeper, who in turn checks against clock cards, makes pay-roll entries and cost distribution. He accomplishes his entire timekeeper's work in about three hours.

MILLING REPORT

Lot No.................... Body No.................. Date..................

	Mill No.	Mill No.	Mill No.	Mill No.	Mill No.
Flint					
"					
"					
Feldspar					
"					
"					
"					
Clay					
"					
Water					
Viscosity					
Weight					
Temperature					
Screen Test					
Time Started					
Time Finished					
Revolutions					
			BLUNGING		
Clay					
"					
"					
"					
White Ware Scrap					
Glaze Scrap					
Sodium Silicate					
Water					
Time Started					
Time Finished					

GLAZE MILL

	Mill No.	
Glaze No.		
No. of Pounds		
Time Started		
Time Finished		
Viscosity		
Temperature		
Weight		

STORAGE TANK

No. Feet of Slip in Tank	
Temperature	
Weight	
Viscosity	

EQUIPMENT INSPECTION

Mills	
Blungers	
Pumps	
Lawn	
Agitators	
Scrap Blungers	

MATERIAL STOCK WARNING:—

DELAYS AND REMARKS:—

Material Requisitions

The material requisitions give account of all material used. They are of two classes: (*a*) for production raw materials; (*b*) for maintenance or manufacturing supplies.

Class "A" Production of Raw Materials

Each batch of ceramic raw material withdrawn from bins is weighed and listed on a day sheet. These sheets go to the bookkeeper and are means of keeping perpetual inventories and of making material charge for month, from which the slip cost per month is obtained. Physical inventories of raw material in bins and slip in tanks are taken the first of each month and thus the perpetual inventory checked and corrected if need be. A similar system applies on all hardware and other production raw materials used in the plant.

Maintenance and Manufacturing Supplies

Maintenance and manufacturing supplies are kept in the factory storeroom. These materials can be withdrawn only through a storeroom requisition. The accounting of these materials is done then by the bookkeeper in the usual manner of storekeeping.

REQUISITION ON STOREROOM

..............Date..............................Charge to..................................

Quantity	ITEMS	Price	Amount

Received By	Approved By	Entered on Stock Record

Production Records

Lot Records

Our lot production records give us a really big return for the small effort they involve.

They prevent confusion in the shop; they give all counts and inventories of work in process; locate at any time the exact position in process, and status to date, of any production order; and they leave behind a permanent history of process conditions and technical data upon each order and lot of the order manufactured.

The need of such a system is evident. We manufacture sixteen different standard types of porcelain, as well as specials, when such orders are received, and the same molds, racks, forming machines and other equipment are used for several of these types. While our standardization of design and process does give great flexibility and does mean little or no idle equipment, it must be recognized that such conditions make systematic production planning and routing imperative.

Production Order Form

Before starting manufacture production each type and each order of porcelain is scheduled upon the production order form (see page 651):

Since it is necessary to see that these production schedules are maintained or if they are not to make process adjustment, a systematic accounting and knowledge of the location in process is demanded covering each production order. The lot production records perform this function.

The lot records originate from sheets filled in by each department foreman covering each lot on each production order that moves into and out of their department.

MAINTENANCE ACCOUNTS

MILLING AND GLAZE MAKING EQUIPMENT

101 Motors, Wiring, and Electrical Equipment
102 Line Shafting, Pulleys and Hangers
103 Clutches
104 Belting
105 #1 Mill
106 #2 Mill
107 #3 Mill
108 #4 Mill
109 #1 Blunger
110 #2 Blunger
111 #3 Blunger
112 #4 Blunger
113 Slip Pumps
114 Slip Lines and Valves
115 Slip Tanks and Agitators
116 Water Lines or Hose
117 Milling Room Trucks and Tools
118 Milling Room Office and Fixtures
119 Milling Room Scales
120 Scrap Blungers
121 Glaze Mills and Blunger
122 Glaze Pumps and Lines
123 Glaze Tanks and Agitators
124 Indicating and Recording Instruments
125 Distilled Water System
126 Testing Apparatus
127 Oils and Waste
128 Lawn
129 Clay Disintegrating Equipment

CASTING EQUIPMENT

201 Slip Working Tanks and Agitators
202 Slip Pouring Lines and Hose
203 Mold Racks or Stillyards
204 Steam Heating Coils, Lines, Regulators and Valves
206 Molds (including renovating)
207 Portable Racks and Rack Boards
208 Casting Room Tools
209 Casting Room Office and Fixtures
210 Indicating and Recording Instruments
211 Mold Renovating Equipment
212 Pouring Nozzles
213 Vacuum Casting Machine
205 Vacuum Return Lines and Traps

DRYING EQUIPMENT

301 Motors, Wiring and Electrical Equipment
302 Line Shafting, Hangers and Pulleys
303 Clutches
304 Belting
305 Fans
306 Steam Heating Coils, Lines, Regulators and Valves
307 Vacuum Return Lines and Traps
308 Humidity Steam Equipment
309 Indicating and Recording Instruments
310 Drier Structure
311 Drier Tools and Fixtures
312 Trucks
313 Control Weighing Equipment
314 Oils and Waste

FORMING AND GLAZING EQUIPMENT

401 Motors, Wiring and Electrical Equipment
402 Shafting, Hangers, Pulleys, Clutches
403 Belting
404 Facers
405 Groovers
406 Drills
407 Sponging Tables
408 Glazing Equipment
409 Dust Exhaust System
410 Forming Room Tools and Trucks
411 Forming Room Office and Fixtures
412 Pin Type Forming Equipment
413 Special Insulator Forming Equipment
414 Vacuum Lines and Equipment
415 Oils and Waste
416 Universal Drilling Machine
417 Universal Profiling Machine
418 Cutter Blades

KILNS AND KILN SETTING EQUIPMENT

501 #1 Kiln Cars and Car Brick Work
502 " Pusher and Track
503 " Exhaust Fans
504 " Water Cooling Equipment
505 " Indicating and Recording Instruments
506 " Kiln Structure
507 " Burners and Flame Shields
508 " Chains and Rollers
509 " Transfers and Gages
510
511
512 #2 Kiln Cars and Car Brick Work
513 " Pusher and Track
514 " Exhaust Fans
515 " Water Cooling Equipment
516 " Indicating and Recording Instruments
517 " Kiln Structure
518 " Burners and Flame Shields
519 " Transfers and Gages
520
521 Sagger Loading Equipment
522 Steam Pusher Engine
523 Car Hauling Equipment
524 Gas Lines, Regulators and Valves
525 Kiln Tools
526 Fixtures and Kiln Office
527 Vacuum Placing Equipment
528 Bitstone Screening Equipment
529 Oils and Waste

ASSEMBLY AND CRATING EQUIPMENT

601 Suspension Type Jigs
602 Heavy Flange Jigs
603 Alloy Pots and Equipment
604 Racks
605 Tools and Fixtures
606 Gas Lines
607 String Assembly and Crating Tables
608 Post Type Assembly Equipment
609 Storage and Loading Docks
610 Assembly Department Office Fixtures
611 Storage Platforms

LABORATORIES AND INSPECTION EQUIPMENT

701 Ceramic Laboratory Apparatus
702 Electrical Laboratory Apparatus
705 Boxes
706 Fuchsine Equipment
707 Pull Test Machine
708 Oscillators
709 Tools and Fixtures
710 Scales
711 Trucks

SAGGERS AND WAD CLAY EQUIPMENT

801 Motors, Wiring, and Electrical Equipment
802 Shafting, Pulleys and Hangers
803 Belting
804 Clutches
805 Pug Mills
806 Press
807 Grog Mill and Housing
808 Grog Elevators
809 Racks
810 Drier Sagger
811 Clay Drier
812 Wheelbarrows and Tools
813 Oils and Waste
814 Pat Press

MOLD MAKING EQUIPMENT

901 Mold Shop and Equipment

GALVANIZING EQUIPMENT

1001 Rumbling Equipment
1002 Pickling Equipment
1003 Drilling and Emery Wheel Equipment
1004 Transmission Machinery
1005 Galvanizing Pots
1006 Indicating and Recording Instruments
1007 Electro Galvanizing Equipment
1008 Shaking and Quenching Equipment

GALVANIZING EQUIPMENT (CONTINUE

1009 Exhauster Equipment
1010 Fixtures and Tools
1011 Hardware Boxes

STORAGE - MATERIALS AND SUPPL

1101 Clay Bins
1102 Hardware Bins
1103 General Storeroom Bins and Shelves
1104 Fixtures
1105 Equipment Shed
1106 Maintenance Store Sheds
1107 Yard Storage
1108 Elevators and Transporting Equipm
1109 Unloaders, Wheelbarrows and Shove

MACHINE SHOP AND TOOLS

1201 Drill Presses and Power Saws
1202 Milling Machine and Shaper
1203 Lathes
1204 Grinders
1205 Tool Crib
1206 Bench and Bench Tools
1207 Carpenter Tools and Equipment
1208 Tinners Tools and Equipment
1209 Pipe Fitters Tools and Equipment
1210 Electricians Tools and Equipment
1211 Welders Tools and Equipment
1212 Blacksmith Tools and Equipment
1213 Wheel Dressing Equipment
1214 Concrete Mixer
1215 Oils and Waste

HEAT, LIGHT AND POWER EQUIPME

1301 General Steam Lines
1302 General Electric Meters and Wiring
1303 General Gas Meters and Piping
1304 Boilers
1305 Boiler Feed Apparatus
1306 Stacks
1307 Tools and Fixtures
1308 Electric Light Bulbs
1309 Pumps and Air Compressors
1310 Oils and Waste

FIRE, WATER AND SEWERAGE SYS

1401 Sprinkler System
1402 Fire Hose and Extinguishers
1403 Water Storage Tanks
1404 General Water Lines
1405 Drinking Water System
1406 Factory Toilets
1407 Office Toilets
1408 Sewer Lines
1409 Chemical Tanks and Equipment
1410 Shower Baths

BUILDINGS, YARDS AND GROUN

1501 Roofs
1502 Building Structure
1503 Floors (All departments)
1504 Windows and Doors
1505 Ceramic (Back) Yard
1506 Side Yards
1507 Front Yards
1508 Roads and Walks
1509 Heating Equipment
1510 Garage
1513 General Painting

MAINTENANCE SALARIES

1601 Storeroom Keeper
1602 Watchmen
1603 Janitors
1604 Vacation Salaries
1605 Time Keeper

MISCELLANEOUS

1701 First Aid Equipment
1702 Miscellaneous Trucking
1703 Janitors Supplies
1704 Maintenance Inspection
1705 Miscellaneous Safety Work
1706 Lunch Tables
1707 Telecall System
1708 Office Fixtures

JEFFERY-DEWITT INSULATOR CO.

PRODUCTION ORDER NO........................

Type No.................Factory Order No................Its Date of Issue................

Purchaser...

Number Finished Units Required...............Date Manufacture to be Complete............

DESCRIPTION OF PRODUCT

Drawing No. of Mold Used.................. Drawing No. of Cast Blank...................

Drawing No. of Formed Stage............... Drawing No. of Fired Stage...................

Drawing No. of Assembled Unit............. Physical and Electrical Specifications.........

Remarks: ....

....

....

PRODUCTION REQUIREMENTS

(1) To be made from Body No............. (2) Number Molds Required.................

(3) How Cast............................ (4) Casting Space Required..................

(5) Forming Tools Req. Order No.......... (6) Glaze Specified.........................

(7) Firing Pats Required.................. (8) Sagger Requirements:

Remarks: .... Number Needed per Day..............

.... Type of Sagger......................

PRODUCTION SCHEDULE BY DEPARTMENTS

	DUE				ACCOMPLISHED				
	Date order started	Date order finished	Number in lot or (per day)	Total No. expected this dept.	Date: Order start	Date: Order finish	Total No. finished this dept.	Lot numbers inclusive	Per cent loss
Molds									
Casting									
Drying									
Forming									
Kiln-Set									
Inspection									
Assembly									
Shipping									
Total									

Cost Sheet No........................... Lot Numbers from......to.........Inclusive

A Lot A lot is that number of units originated or cast each day for the particular type or production order. The production order sheets designate the number.

These lot records are used by each department foreman and are padded together.

One pad is entered with each lot started at the casting department. When the lot itself actually leaves the casting department (to enter the

CASTING

TYPE NO.________

Production Order No.______________ Lot No.____________ **1**

Number Cast ______________________________

Date Cast______________ Date Removed______________

Number Good ______________________________

JEFFERY-DEWITT INSULATOR COMPANY

CASTING PRACTISE

Date Lot Delivered ____________ TYPE No.____________ P. O. No.____________ Lot No.____________

SLIP AT CASTING					
Tank	Viscosity	Temp.	Weight per Pint	Settle Ratio	Specific Gravity

DRY CONTROL WEIGHTS			
Let-ter	Wt. Blank Into Dryer	Wt. Blank Dried	Avr. water to be removed lbs. %

Signed ______________________________

Age of slip when cast ______________________________

Hours Steam on empty molds______________ Temp.______________

Hours insulators in molds ______________ Age of molds______________

REMARKS:

GREENWARE DRYING

TYPE NO.________

Production Order No.______________ Lot No.____________ **2**

Number Received ______________________________

Date Loaded ______________ Date Removed______________

Total to Forming Room______________________________

DRYING PRACTISE

Date Lot Delivered to Wt. Control______________

____

TYPE No.____________ P. O. No.____________ Lot No.____________

Date into air dry__________ Out__________ Hours in air dry__________

Average temp. in air dryer________ Dry Bulb________ Wet Bulb________

Into Drier No.__________ Date In__________ Date Out__________

Run No.______________ Days in Drier______________

Wet Bulb__________ DRIER OPERATION Dry Bulb__________

Hrs.	Temperatures 70	80	90	100	110	Weight of Blank					
12											
24											
36											
48											
60											
72											
84											
96											
108											
120											
132											
144											
156											

JEFFERY-DEWITT INS..LATOR CO.

CONTROL WEIGHT

Number Overweights______________ %______________

Location Overweights ______________________________

____

Stillage, Weights—Dry ______________________________

____

FORMING AND GLAZING

TYPE NO.________

Production Order No.______________ Lot No.____________ **3**

Number Received____________ Delivered ____________

Date Formed______________ Losses______________

Delivered to Kiln Set______________________________

FORMING DEPARTMENT

Date delivered to Kiln Set______________

TYPE No.____________ P. O. No.____________ Lot No.____________

Glaze No.______________ Color______________

Moisture in Ware____________ Hub__________ Skirt__________

JEFFERY-DEV T INSULATOR

CASTING DEPARTMENT	
Air Holes	
Hub Holes	
Hub Cracks	
Groove Cracks	
Wire Cracks	
Boards off Racks	
Ceramic Lab. or Testing.	
Hub off Side	
Spauled	
Pouring Cracks	
Mashed Down	
Plaster	
Floated Lids	
Bumped	
Total Charged Casting	

DRYING DEPARTMENT	
Dryer Cracks	
Bumped in Dryer	
Dryer Testing	
Total Charged Drying	

FORMING DEPARTMENT	
Groover	
Facer	
Belt Trouble	
Drill	
Glazer	
Bumped	
Total Charged Forming	
Total loss at Forming Insp. %	

Kiln Setting

TYPE NO.________

Production Order No.________ Lot No.________ **4**

Number Received________ Delivered ________

Date Loaded ________

Kiln Setting Loss ________

No. Into Kiln No. 1________ No. 2________ No. 3________

Total No. into all Kilns________ Number Cast________

Kiln Setting

TYPE No.________ P. O. No.________ Lot No.________

Moisture in ware, Hub________ Skirt________

Date Start Loading________ Date Finish________

Crew No.	Car No.	Amount on car	Crew No.	Car No.	Amount on car
KILN NO.____			KILN NO.____		
	Total			Total	

JEFFERY-DEWITT INSULATOR CO.

Kiln Burning

TYPE NO.________

Production Order No.________ Lot No.________ **5**

Number Into Kiln________ No. Unloaded________

Date Unloaded________

Total No. Underfire ________

Total No. O. K. for Visual Insp.________

Kiln Burning

TYPE No.________ P. O. No.________ Lot No.________

Date out Kiln________ CONE CHART % underfire loss________%

Kiln No. ____				Kiln No. ____				Kiln No. ____			
Car	T	B		Car	T	B		Car	T	B	
			D				D				D
			H				H				H
			T				T				T
			D				D				D
			H				H				H
			T				T				T
			D				D				D
			H				H				H
			T				T				T
			D				D				D
			H				H				H
			T				T				T
			D				D				D
			H				H				H
			T				T				T
			D				D				D
			H				H				H
			T				T				T
			D				D				D
			H				H				H
			T				T				T
			D				D				D
			H				H				H
			T				T				T

OPTICAL READINGS

Kiln No. ____		Kiln No. ____		Kiln No. ____	
Position	Temp.	Position	Temp.	Position	Temp.

JEFFERY-DEWITT INSULATOR CO.

TYPE NO.________

Porcelain Inspection

Production Order No.________ Lot________ **6**

Total No. O. K. Fuchsine for Inspection________

Number Rejected at Inspection ________

Total Number Accepted ________

Date Inspection Complete ________

Porcelain Inspection

TYPE No.________ P. O. No.________ Lot No.________

Date Inspection: Start________ Finish________

VISUAL INSPECTION

	Kiln No.____	Kiln No.____	Total
Lower Hub ____			
Upper Hub ____			
Shoulder ____			
Groove ____			
Skirt ____			
Handling Chip ____			
Kiln Chip ____			
Sandy ____			
Overfire____			
Total ____			

TESTING

Results of Puncture Test	Test	Results Tensil Test
	1	
	2	
	3	
	4	
	5	
	6	
	Total	
	Aver.	

JEFFERY-DI TT INSULATOR

drying department) the casting department sheet, now filled in, is torn off and sent to the superintendent's office and the rest of the pad goes with the ware to the drying department. And so, throughout the process, the pad goes with the ware and the filled-in sheets are torn off and sent to the superintendent's office. However, since the sheets are padded in duplicate each department keeps a copy of this record.

These record sheets are now to serve at the superintendent's office several uses: (1) a tally against the schedule called for on the production order; (2) to supply the counts of ware in process and to give the location of each lot in process; (3) to give the perpetual inventory figures for wares in process and stock; (4) to give the process data covering technical information.

Each sheet is perforated. The upper part is used for the count, inventory and position records. These slips have certain data recorded on the count charts at the superintendent's office.

Then the slips themselves are put into the count tally board. This board files all slips coming to the office for the month. Reference really determines just where each lot is in actual factory position, how much of any order is filled and when it will be completed. You will note that the processing data covering each lot found on the main part of each lot record is pretty complete.

There are established standard process conditions. With these records we can compare actual against standard at a glance. That such is a manufacturing help is obvious.

These slips are filed in small loose leaf books.

A set of books for each type of porcelain and a book for each department are given. Thus, we have a live, up-to-the-minute ready reference library on production and process.

However, we believe in charts and curves. We feel that the general trends and their resultants are best shown in this way, so vital elements of data are plotted on charts and the trends watched. These charts we find most valuable in settling matters of what is right and wrong practice, and they give us opportunity of getting exact knowledge of technical matter that we have gotten in no other way. Charts allow us to plot losses against process conditions.

Finally, we have a sheet that assembles all this process and account record.

These sheets are readily filed in loose leaf books by types and form a final or historic record. This last record is not used as frequently as the others perhaps, yet, when wanted quickly, particularly for history, is useful enough to warrant keeping it.

It should be realized that in our case all types and lot of production go through the same flow, that is, each have the same route through the

LOT PRODUCTION REPORT

Lot No.........................

Date Cast.........................

MILLING

Body No........................

Residue on 300 Mesh Screen One Pint of Slip..................

Lbs. Sodium Silicate per Mill......................

CASTING

Properties of Slip

Temperature..........Viscosity..........Weight.............

Time of Casting by Lab. Test...............................

Age of Slip When Cast.......................................

Hours Steam on Empty Molds...........Temp...............

Hours Insulators in Molds............Age of Molds............

% Casting Loss Reported by Forming Department...........

GREENWARE DRYING

Date into Air Dry.............Date Weighed................

Average Temp. in Air Drier....Dry Bulb......Wet Bulb......

Date into Drier No...........Date Fan Off..................

Max. Weights as Follows:

Stillage..

Weight..

% Overweight..

% Drier Loss Reported from Forming Department............

Strength of Green, Dry Body Modulus of Rupture by Lab. Test..

FORMING

Date Formed..

% Forming Loss (Machines)...............................

Glaze No..

Moisture in Ware Passing Weight of Inspection

Hub..................Skirt...........................

Moisture in Redried Ware

Hub..................Skirt...........................

PROCESSING:

Groover..

Facer..

Drill..

Sponging..

Palleting..

Glazing..

GLAZE DRYING AND KILN SETTING

Date into Air Dry..

Date into Drier No..

Date O. K. to Set..

Date Inspected..

Moisture When Inspected

Hub.....................Skirt........................

FIRING

Kiln No.......................Date in..................

Date out..................

% Under Fire Loss..

% Over Fire Loss..

Average Cone Bottom Sagger...................................

No. Cast	
Loss	
% Loss	
No. Received	
Loss	
% Loss	
No. Worked	
Casting Losses	
Drying	
Forming	
Total	
% Loss	
No. Glazed	
No. Inspected	
Loss	
% Loss	
No. Loaded	
Kiln Loss	
% Loss	

VISUAL INSPECTION Per Cent Loss as Follows:		
Lower Hub..........	No. Inspected	
Upper Hub..........	No. Rejected	
Shoulder..........	% Loss	
Groove..........	No. Accepted	
Skirt..........	% Accepted	
Misc..........	Of No. Cast	
Total..........		

FINAL INSPECTION AND TESTING

Note any Unusual Loss..........

....

....

Tensile Strength of Units Given Puncture Test..........

Results of Puncture Test..........

STATION INDEX REPORT

Losses	Dried Blanks	Blanks Grooved and Faced	Completely Formed Unglazed
Lower Hub			
Upper Hub			
Shoulder			
Skirt			
Misc.			
Total			

plant. Again in our case all porcelains are made from the same slip. The milling room, in our sense, precedes the start of manufacture, it supplies a raw material and only the one standard slip. This means, too, in our accounting department the slip room sells the slip by the pound to the rest of the process. Thus, the material costing is simplified. Then, too, in like manner, finished, fired and accepted porcelains only are sold the insulator assembly division and likewise by such a conception is accounting and recording simplified.

JEFFERY-DEWITT INSULATOR CO.
KENOVA, W. VA.

Discussion

E. H. FRITZ: Do you keep that record only on your one standard style of insulator, or all styles?

W. K. MCAFEE: All styles of insulators have the form he has shown you there.

E. H. FRITZ: Will there be more than one style made in one day?

P. H. SANBORN: Yes, there may be as many as ten different ones being made in a day and each one will have that same system to go through.

E. H. Fritz: That would be a maximum?

P. H. Sanborn: It probably would be.

E. H. Fritz: If you are making a greater variety of styles the system is more difficult to make use of and takes more time to keep up.

R. E. Elliott: We keep similar records in our factory daily of the production of every department, but we have found it not to be of any advantage to compile the cost figures monthly. We did start doing that but we found that by taking the longer period it gives us a much better result and gives all the information required as far as actual cost figures are concerned, but so far as production and loss figures are concerned the shorter period might be the better as a protection.

The paper, of course, being applied to electrical porcelain, did not bring out some points which apply particularly to sanitary ware. For instance, in figuring the cost of the sanitary piece we base our cost on the cubical content in the kiln. That was a point which was not brought out. I do not know whether that applies to most factories or not, but we found it a very satisfactory method.

W. K. McAfee: Do you mean in distributing the overhead or burden?

R. E. Elliott: Yes, and even in distributing the operating expenses because after all those little pieces cost exactly in proportion to the space they occupy in the kiln.

W. K. McAfee: There are other factors that enter into that. It is conceivable that some pieces take relatively more space in the casting than they do in the kiln due to complicated molds, etc. That is, they should get a comparatively higher percentage of the casting shop overhead than they should of the kiln overhead.

R. E. Elliott: We have discovered that it is hardly worth our while to differentiate between a lot of different items of overhead. As a matter of fact, we have a general overhead expense, and if we distribute it into one portion we get about all the information we need. We could subdivide it but I do not think the information amounts to very much. After all, we have a general overhead expense to add to a piece and if we apply it in a certain ratio we are getting about the same results.

F. S. Hunt: My experience in distributing overhead and various expenses is that we have to analyze the particular plant to which we are applying the system. It is very seldom that different plants will have the same conditions or the same problems. It is true that sanitary men have all the same problems or porcelain men or semi-vitreous or insulator men, but when we pass from one to the other we find an entirely different proposition and have to solve it in its own particular way.

PROPER SIZING OF MATERIALS FOR BRICK

By F. P. Nickerson

When referring to the sizing of material for brick, quite frequently we have in mind the size of the largest particles present and have a rather hazy conception of what goes to make up the balance of the structure.

In years gone by, the manufacturer would select a sizing or a limitation to the size of the largest particles that should be permitted in his product, and quite frequently that selection would be controlled by the effect those particles would have on the appearance of his product. He would attribute any other grievance that might be encountered in the process of manufacture to any and everything else from the clay pit or mine to the railroad car, and disregard the sizing of everything except the largest particles that should enter the mix.

I can recall when it was no uncommon thing for the paving brick salesman to point with pride to the uniform, fine grained texture of his brick when trying to interest some councilman or commissioner and assume a quality factor because of that fineness. Quite frequently that grain and texture was such as to produce a very high grade brick owing to the fact that the clay or shale and the disintegrating units and the screening or classifying equipment all happened to so fit the other requirements that a tolerably good proportioning of the many sized particles resulted.

His competitor may have had a material that did not so readily lend itself to the production of this fine grained, nicely finished product without encountering troubles that would be more grievous than the absence of a fine grain. In an endeavor to produce a fine grain and smooth finish product he would suffer losses from body ruptures, surface checks or cracks, ghastly lines of lamination or an uneven shrinkage and quite often blisters on the face of his brick. The available clay or shale, the machines that are doing the grinding and the machinery for classifying materials according to size (the screen) failed to harmonize; thus a fine grained product could only be obtained by taxing some other factor of quality.

Not all of the troublesome effects that I have mentioned are caused solely by improper sizing, but sizing (not only the size of the largest particles present, but all of the sizes that enter into the construction of a brick) has an influence that cannot be ignored.

Designing a Brick

For the sake of illustrating some of the points that have come to my attention I would like to use the term "design," meaning that we shall build a brick, not just miscellaneously out of a material that will pass through one given sized opening, but that we shall keep in touch with the various sizes that go to make up the aggregate of the brick.

We shall take a quantity of shale and clay and put it through the ordi-

nary process of disintegration and from that disintegrated mass classify or separate as to size and make five classifications of the results of the operation. Let us elect that the largest particle admissible to this aggregate shall not exceed $^1/_8$ inch in diameter; therefore after passing it through a $^1/_8$-inch opening the residue or first classification shall be excluded from the mix and be returned for further grinding.

Next, let us take from the material that has passed through the $^1/_8$-inch opening and pass as much as will go through a $^1/_{16}$-inch opening. The diameter of the largest particle that passes through the $^1/_{16}$-inch opening will be half that of the largest particle that passes through the $^1/_8$-inch opening. Again pass what will of the $^1/_{16}$-inch product through a $^1/_{32}$-inch opening and the product of the $^1/_{32}$-inch opening through a $^1/_{64}$-inch opening. This will give four classifications of sized particles out of which a brick is to be constructed having eliminated the first classification by reconsigning it to the grinding unit.

At the point of each separation after the first one the largest sized particle is just half the diameter of the largest particle present in the preceding classification, approximately one-eighth the volume and twice the area in ratio to volume.

The total area of each particle must be moistened with a film of water to stick it fast to its neighbors. The smaller the particle the nearer the volume of water carried becomes equal to the volume of the particle.

There is a limit to the quantity of these little particles that will be allowable, irrespective of the size of the largest particle admitted. Ignition loss must follow, water must again be eliminated and the little bonds that have been made will be strained and if there is not a sufficient number of the big brothers and half-grown brothers and intermediate ones so they can reach each other's hands without straining too hard, there will be a break in the family tie of that brick.

I have one case particularly in mind where paving brick are made. The material is an open bank shale, not uniform in hardness, covered with a blanket of surface clay varying in thickness from two to ten feet. Originally, the operation was such that there was a wide variation in the sizings that went into the brick, except that all of the product went through a certain kind of an opening. The size of the largest particle admitted into the brick from time to time was fairly uniform except as influenced by the difference in the character of the material striking against the opening. There was just as wide a variation in the results obtained in the abrasion tests as there was in the sizings that went into the brick. Any one familiar with this trouble knows what that means. It is a very unhappy state of events to have the abrasion loss run 25% when the specifications of the job are limited to 22%. The fact that one test out of three might have run 16% does not compensate for the one that goes 25%.

A total average of the screen analyses made on the operation showed that one-half of 1% was larger than $^1/_8$ inch in diameter, that 12% was $^1/_8$ inch and smaller, but larger than $^1/_{16}$ inch in diameter, that 25.8% was between $^1/_{32}$ inch and $^1/_{16}$ inch in diameter, 17% was between $^1/_{64}$ inch and $^1/_{32}$ inch in diameter and that the remaining 34.7% was smaller than $^1/_{64}$ inch in diameter. This mixture made a fairly good brick and passed the requirements of rattler specifications. Frequently when the material was damp and the various units of disintegration and classification were not delivering efficiently, the size of the largest particles changed 10% or 15% and the rattler loss increased.

They finally changed their screening operation so as to more nearly control the sizing and struck an average as follows: All passed $^1/_8$-inch opening. 25% stayed on the $^1/_{16}$-inch opening, 27% on the $^1/_{32}$-inch opening, 19% on the $^1/_{64}$-inch opening and the remaining 29% passing the $^1/_{64}$-inch opening.

Screen analyses were made for a period of five months, and rattler tests were made from various parts of the kiln. The screen analyses were surprisingly uniform and the rattler tests did not vary over three points from the average and the most of them went within $1^1/_2$%. The total average rattler loss was reduced more than 3%. At no time have they since run above the specification requirements for road construction.

On comparing a large number of screen analyses with the product results I have found that the controlling of the proportion of the sizings has a direct bearing on quality and uniformity.

Probably the exact proportion of the sizings that will make the best brick out of a variety of clays, will vary with each variety of clay. I am impressed with the belief that there is a proper proportion of the various sizings or sizes that will make from any given clay the best brick.

A comparison of screen analyses with the fired product shows that controlling the proportion of the various sizes has a direct bearing on quality and uniformity.

Evidently there is a proper proportion of the various sizes that will make the best brick from any given clay, but the proportioning will be different for each variety of clay that is employed.

W. S. Tyler Co.
Cleveland, Ohio

PLANT PLANNING

By T. W. Garve

ABSTRACT

A guide for plant planning is given concluded with flow sheets for heavy clay products from characteristic clays.

So many factors are involved in plant planning that it seems desirable to set down the essentials. This we have done in form of a schedule with accompanying brief discussions. Such a schedule can be varied to suit any particular case.

1. Sanitation and Safety

(a) Light, Ventilation and Heating; (b) General Cleanliness; (c) Dust Elimination by Fan Suction

No one can question the importance of these items. Architects and engineers provide for them, but too often their plans are not carried out. A factory where poor light and bad air, where dirt, grease, junk and dust are everywhere in evidence will always have a large labor turn-over and a low morale. The cost for providing these items is small but great is their value.

Avoid small courts and dark corners where dirt can easily accumulate. If shelves are used, they should be open and large and be placed where there is abundance of light, this being an essential not alone for cleanliness but also for fire protection.

A room or separate building should be provided with lockers for the men, with toilets and even showers.

Dust producing machinery should be boxed in and connected by piping to a dust arresting box and fan to eliminate the dust.

(d) Safety Appliances

This includes gear and belt guards on all machines, headroom in passages and stairways, hand railing for all platforms and stairs and the necessary fire protection. The distance from center railroad track to retaining wall or any building is not less now than eight feet.

2. Simplicity

(a) Routing Laterally

The routing should be as short as possible without necessarily being in a straight line. A U-shaped plan often works out to greater advantage and greater simplicity than a straight line, if light and ventilation are not sacrificed. The plant will thus be a more concentrated unit, allowing of better accessibility and inspection, and shortening the distance of empty return cars. It is always the same problem: that the product of time, mass (tonnage) and distance, equal to work, be a minimum.

(b) Routing Vertically

It is best, if possible, to resort to initial elevation of the raw materials and gravity in the subsequent steps. Elevators often are full of trouble, conveyors less so but not immune. One should endeavor to eliminate elevators and conveyors as far as possible, but, where they are unavoidable it is essential that they be of ample capacity, the right type and properly installed with ample working space around the head and tail pulley equipment. If the losses in clayworking factories, directly traceable to elevators and conveyors, could be tabulated and presented to clayworkers, greater attention would be given to this secondary equipment.

(c) Buildings

While it is costly to build strictly fire-proof it will pay in the long run. For clayworking plants the so-called "slow burning mill type" is often the most adaptable. While appearance is in favor of steel, it, if unprotected, is less fire resisting than heavy timber. Avoid narrow joists and rafters.

The buildings should be simple in design and roomy even though there may be some waste of space in favor of directness and simplicity.

(d) Machinery and Machine Settings

Provide for substantial machinery without vibrations and of ample capacity. The horse power should be determined as accurately as possible if individual electric motors are to be used. The selection of proper machinery is a concomitant of experience, judgment and a knowledge of the raw materials and difficulties of the wares to be produced, and hence cannot be taken up here.

The clayworker should work out his own foundation plans, regardless of plans submitted, to be sure of later accessibility, of simplicity and rigidity.

Too many factories are built along the line of "solving that problem when we come to it" and not only show it but the manager apologizes for the mistakes "we made" in laying out the plant. Only by solving every conceivable contingency in the original plans can final plant simplicity be obtained.

3. Continuity

(a) Clay Storage

Shall raw clay or ground clay be stored? Where the clay pit is accessible, and unfrozen or undrowned clay is available all year, a raw clay storage is not a necessity and the crushed and ground storage facilities within the factory will suffice to take care of small irregularities of the pit or transportation equipment. Clay under ground is always dry and never frozen and underground mining does not as a rule require raw clay storage.

Clay storage gives a better mixture. Crushed as well as ground clay should be stored to insure continuity of operation in case of a temporary breakdown of a crusher, pan, elevator, etc.

(b) Repairs and Facilities for Such Investigate all machinery in regard to the manner in which repairs have to be made, and keep this point always in view while planning settings and installations. Order duplicates of wearing parts at the very beginning.

4. Economy

(a) Clay Winning How? Pick and shovel; team scrapers and clay gatherers; steam, electric or gasoline driven shovels; drag line scraper; ditchers; shale planer; which? It is a problem for careful investigation of the material and thorough study of the problem of winning.

(b) Arrangement The subsequent steps in manufacture of the different units should follow each other in proper order eliminating conveying machinery and rehandling to a minimum, all to be efficiently arranged between the terminals of the incoming clay and the outgoing ware. Work out flow sheets (see later) and preliminary layouts.

(c) Waste Clay Equipment It should be automatic and out of the way. It can be underground or overhead or both as works out best. Chutes, conveyors, elevators, tracks, or overhead monorail can be used. It is a money saver if so constructed that it is no hindrance to the operations.

(d) Feeding Devices Crushers, grinding mills, dry pans, pug mills, etc. should be preceded by suitable feeders, the reciprocating type for coarse and the rotating type for fine material. Rotary mills for fine grinding are usually provided with feeders.

(e) Drives Silent chain will permit of short distances but it requires very exact setting and substantial foundation without the least vibrations. Belt drives should be as horizontal as possible with under pull, of ample width. Machine gears should be of steel.

(f) Coal Handling Coal should be distributed mechanically to save labor. It can be taken from overhead pockets of the railroad trestle and transported to the kilns by gasoline dump tractor or otherwise. It depends much upon conditions but it should not be overlooked since coal is a great item in most clay working plants.

5. Future Extension and Alterations

(*a*) Clay supply
(*b*) Property
(*c*) Plant arrangement
(*d*) Transportation facilities.

In order to get a general preliminary idea in regard to the arrangement

of the plant, it is advisable to draw or write up flow sheets from which the general plant layout later will be developed.

In the following we are giving eight flow sheets of characteristic clays for the planning of heavy clay product plants.

Flow Sheet

1. **Material**
Soft or wet alluvial clay
Surface clay, plastic

Product
Common brick
Face brick
Drain tile
Hollow tile

Screw Feeder
Disintegrator
Rolls
Pug Mill
Auger Machine
Cutter
Off Bearing
Drier
Kilns

2. **Material**
Short or sandy surface clay

Product
Common brick
(Soft mud process)

Rolls or Disintegrator
Automatic Soft Mud Brick Machine
Cable Conveyor or Rack Cars
Drier
Kilns

3. **Material**
Glacial clay containing
gravel, sand and pebbles

Product
Common brick
Face brick
Drain tile
Hollow tile

Granulator or Screw Feeder[1]
Rotary Drier

Storage Hopper	Storage Hopper
Disc Feeder	Disc Feeder
Dry Pan	Dry Pan
Elevator	Elevator
Screen	Screen

Storage Bins
Disc Feeder
Pug Mill
Auger Machine
Cutter
Off Bearing
Drier
Kilns

[1] The granulator for lumpy clay and the screw feederf or ordinary clays.

Flow Sheet

4. **Material**
Extremely plastic clay

Product
Common brick
Face brick
Drain tile
Hollow tile

The Clay:
Storage Hopper
Screw Feeder
Disintegrator
Rolls

The Grog:
Jaw Crusher
Dry Pan
Elevator
Bin
Disc Feeder

Pug Mill
Auger Machine
Cutter
Off Bearing
Drier
Kilns

5. **Material**
Shale and No. 2 Fire Clay

Product
Face brick
(Dry Press Process)

Storage Hopper
Plate Feeder
Single Roll Crusher
Storage Bins
Plate Feeder
Dry Pan
Elevator
Screen (coarse)
Steamer
Storage Bins
Conveyor
Elevator
Storage Bin
Spiral or Screw Conveyor

Dry Pan (or Pulverizer)	Dry Pan (or Pulverizer)
Elevator	Elevator
Screen	Screen
Mixer = (Press Feeder)	Mixer = (Press Feeder)
Press	Press

Kilns

Note: Steamer is merely to soften the clay. Additional water added in final pan.
Note: If clays are soft enough to give clean sharp edges, use flow sheet 5*a*.

Flow Sheet

5a. Material

Shale and No. 2 Fire Clay
(Soft)

Product

Face brick
(Dry Press Process)

Storage Hopper
|
Plate Feeder
|
Single Roll Crusher
|
Storage Bins
|
Plate Feeder

Dry Pan (or Pulverizer)	Dry Pan (or Pulverizer)
Elevator	Elevator
Screen	Screen
Mixer = (Press Feeder)	Mixer = (Press Feeder)
Press	Press

Kilns

For additional information see 5.

Note: If the shales or fire clays are soft enough to give clean sharp edges, eliminate the steamer and the final pan or pans.

The remodeled plant at Shawnee, Ohio, had: "dry pan, screen, steamer, storage, conveyor, elevator, coarse screen for removing foreign matter, mixers, presses. This did fairly well for flashed iron-spot brick but would not make a high-grade face brick, set faced," says Richardson.

6. Material

Hard friable shale

Product

Face brick
Paving brick
Hollow tile

Storage Hopper
|
Plate Feeder
|
Single Roll Crusher
|
Storage Bins

Plate Feeder	Plate Feeder	Plate Feeder
Dry Pan	Dry Pan	Dry Pan
Elevator	Elevator	Elevator
Screen	Screen	Screen

Storage Bins
|
Disc Feeder
|
Pug Mill
|
Auger Machine
|
Cutter
|
Off Bearing
|
Drier
|
Kilns

7. Material

Low refractory plastic
fire clay
Shale of good plasticity and
(high) mechanical strength,
capable of taking good
salt glaze for conduits

Product

Face brick
Hollow ware
Fire proofing
Electric conduits

FLOW SHEET

Hopper
Plate Feeder
Single Roll Crusher
Storage Bins

Disc Feeder	Disc Feeder
Dry Pan(s)	Dry Pan(s)
Elevator	Elevator
Screen	Screen
Bin	Bin
Disc Feeder	Disc Feeder
Pug Mill	Pug Mill
Combination Machine	Combination Machine
Cutter	Cutter
Off Bearing	Off Bearing

Drier
Kilns

8. MATERIAL
Shale, plastic and strong capable of taking salt glaze

PRODUCT
Sewer pipe
Electric conduits

Hopper
Plate Feeder
Single Roll Crusher
Storage Bins

Plate Feeder	Plate Feeder	Plate Feeder
Dry Pan	Dry Pan	Dry Pan
Elevator	Elevator	Elevator
Screen	Screen	Screen

Storage Bins
Measuring or weighing device for batch; dump cars or no cars

Wet Pan	Wet Pan	Wet Pan	Wet Pan

Elevator	Elevator
Storage Feeder	Storage Feeder
Second-floor Press	Third-floor Press

Dry Floors
Kilns

Acknowledgment is due Mr. Lovejoy for going over the paper and many helpful suggestions.

ECONOMICS OF THE CAR TUNNEL KILN

By John L. Carruthers

ABSTRACT

The advantages of the car tunnel kiln over the periodic kiln claimed by different designers are reviewed. The installation of a car tunnel kiln from an investment standpoint is discussed. Consideration of factory layout, capacity, nature of raw materials and the characteristics of the ware to be fired is essential in planning a tunnel kiln installation. The economic features of tunnel kilns to be investigated before buying are discussed, as are also the problems that may arise in a factory incident to the installation of this type of kiln.

Introduction

The car tunnel kiln is today an accepted piece of equipment in the clay products industry. The kiln is not yet ideal or perfect, as there are improvements and refinements constantly being made in both design and application. It can be safely said, however, that the tunnel kiln has now passed through the experimental and development phase of its existence and is being generally recognized as a necessary "device" or "piece of equipment" in the scheme of economical production of the modern clay products factory. Also in the next ten years there can hardly be the advancement made in tunnel kiln design that the last five years has brought forth.

The *Journal of the American Ceramic Society* and trade periodicals have published at various times technical articles in regard to the tunnel kiln. These articles have, as a rule, dealt with operating data and results of certain tunnel kiln installations as compared to previous practice, the advantages and disadvantages of the different types of car tunnel kilns, the possibility and application of the tunnel kiln to certain industries and other interesting items. However, there is little, if any, literature that describes which features and qualifications of the car tunnel kiln should be investigated by a manufacturer considering the purchase of such a kiln; therefore, it is the purpose of the author to present his views in this direction.

Advantages of the Tunnel Kiln

Advocates of the car tunnel kiln claim that certain advantages are to be obtained through its use when compared with the prevalent practice of periodic kiln firing. It is well to know what claims are made by designers before starting an investigation. In the following paragraphs, all claims that the writer has known to be made by different designers in behalf of the car tunnel kiln are discussed, except those with which design is concerned. It is realized that arguments "pro and con" can be made on these claims, but such is not the purpose of this paper. No attempt is made to assign relative values to any of the advantages. These claimed advantages are as follows:

A higher percentage of No. 1 quality ware will be produced by the tunnel kiln because of the more uniform treatment that the clay ware received during the firing process. There is greater uniformity in the application of the heat used. The time-temperature element and the composition of combustion gases are under finer control. Also the distribution and amount of heat throughout the ware setting and the cooling process are more uniform in tunnel kiln action. The use of small settings eliminates losses quite prevalent in periodic kilns, due to the excessive loads carried by the lower pieces of the setting.

Low cost of maintenance is claimed for the tunnel kiln, because the masonry structure is not subjected to the destructive forces of expansion and contraction because of the methods used in applying heat to the ware.

Large fuel saving is a paramount advantage of the tunnel kiln. It is claimed that this saving will be from 40% to 85% per unit of ware as compared with periodic kilns. Regenerative and recuperative methods of heat recovery, together with a well insulated kiln structure, are fundamental in securing such savings.

Reduction of kiln labor costs (placing, firing and drawing) per unit of ware, in connection with tunnel kiln operation, is another advantage claimed. This reduction is attributed to the centralization of the loading and drawing of ware from the kiln, the comparatively small setting units and the better factory layout and production control, which are part of a well designed tunnel kiln installation.

The time required for firing and cooling ware in a tunnel kiln is less than when periodic kilns are used. The period of heat treatment necessary for any ceramic body is dependent upon mass, temperature and the physical and chemical characteristics of that body. In the tunnel kiln, small masses of ware are treated almost as individual units and can be fired in less time with perhaps a slight increase in temperature necessary to balance the operation.

This saving of time is valuable to a manufacturer, in that it decreases to a considerable degree the actual time required to change the raw material into finished product and thus give more rapid turnover of capital invested in material in process.

A tunnel kiln in a factory acts as a pace-maker for the entire organization. The kiln operation is set to a time schedule, consequently all departments must set their speed accordingly.

In the industries using saggers for holding the ware during firing, a tunnel kiln will cause appreciable savings in sagger costs. This is because lighter loads are imposed upon the lower saggers of the bungs and because the handling of the saggers is much less severe than in periodic kilns. Also, the total number of saggers required to maintain a certain production will be less in a tunnel kiln because of the short firing period.

The tunnel kiln presents better working conditions for kiln labor, thus giving greater satisfaction to both employers and employed. In practically all cases, less actual physical labor is required per man per unit of ware handled. The drawing of kilns in which it is too hot for men to work safely and comfortably is eliminated.

Insurance rates are, in general, considerably lower for factories using tunnel kilns in place of periodic kilns. The insurance underwriter does not consider a periodic kiln in a building a very good risk. The lower premium in the case of the tunnel kiln is due to its construction and methods of insulation.

The use of the modern car tunnel kiln is a decided advantage to the clay industry at large, because successful tunnel kiln installations have started, probably as much or more than any other agency, the transformation of the old time clay plant, with its many sources of waste, into a modern efficient factory. The possibilities of the tunnel kiln have opened up the way for the way refinements throughout the clay industry.

The above list of advantages of the car tunnel kiln is only a compilation of those offered by different kiln designers. Special features of any particular car tunnel kiln are the means by which the designer effects the results claimed.

From an Investment Standpoint

One of the foremost thoughts, in the mind of a manufacturer considering the purchase of a tunnel kiln, is what will be the return on the investment? The answer to such a question will vary, depending upon several factors. These are the amount of the initial investment necessary, the savings possible, previous or comparative costs with which tunnel kiln costs will be compared, and whether the most will be made of the efficiency possibilities of the tunnel kiln.

The initial investment in a car tunnel kiln is greater in some cases than that which would be necessary to install a battery of periodic kilns to produce a similar amount of ware. Different types of clay bodies necessarily require different heat treatment, consequently capacity is controlled by the size of the kiln and the rate at which it can be operated to produce proper treatment. Therefore, the production desired will control to a very great degree the major portion of the initial cost.

It is essential for real successful operation, that a tunnel kiln be placed in a suitable building to protect the regulation of the kiln and to provide suitable working conditions for the men employed thereabouts. The cost of this building must be figured as part of the necessary investment. However, in practically all cases, the investment required to house a battery of periodic kilns of equivalent tunnel kiln capacity would be greater in order to obtain improved operating and factory conditions equal to that of the tunnel kiln.

The amount of savings possible with a tunnel kiln will vary with conditions. The factory and kiln layout will govern to a considerable degree the savings in labor costs. The unit cost of fuel, the firing temperature of the ware and the operating capacity of the kiln affect the amount of fuel saving in percentage and actual dollars and cents. The percentage of savings on former costs might be the same on different installations of the same design of tunnel kiln, which are operating on the same class and amount of ware, yet the actual amount of savings may not be alike, because of a change in one of the above factors. Other savings that may be obtained by using a tunnel kiln are dependent upon local conditions and the actual efficiency of the particular kiln under consideration.

If periodic kiln firing costs were high because of inefficient methods, then tunnel kiln operation would naturally produce larger savings than had the opposite been true.

Today, there are numerous successful tunnel kiln installations that a manufacturer can investigate so as to obtain reliable figures from which he can draw his own conclusions. There are several tunnel kilns now operating in which the fuel savings alone are returning to the owners each year 100% of the initial cost of the kiln.

A serious consideration of tunnel kilns by the clay products manufacturer at the present time is only good business foresight as the time is not far off when it will be necessary for practically all clay products factories to use tunnel kilns in order to lower production costs and meet competition. The tunnel kiln owner of today is realizing a larger margin of profit than his competitor who still uses the old style periodic kiln.

Preliminary Data for Investigating Different Designs of Tunnel Kilns

Before a manufacturer actually goes into the market for a tunnel kiln, there are several things to consider and decide, either in his own organization or in consultation with experienced engineers. Such points are factory layout, capacity, nature of the raw material and the characteristics of the particular ware to be fired.

Layout of Factory The tunnel kiln, because of its size, does not often readily fit into the average existing factory. Therefore, considerable study and forethought are required to make the kiln fit into the flow lines of production in the most efficient manner. In a new factory, the plant layout should be governed by the desired location of the kiln. Extra dollars spent in placing a tunnel kiln *in its logical location* will be returned many times when production gets under way. At all times in planning the layout, the idea of further expansion should govern the decisions made.

Production A car tunnel kiln is ordinarily operated every day of the week and production in the shop is main-

tained for only five and one-half or six days of the week. To meet this condition, the manufacturing department and the tunnel kiln must be synchronized in their operation so as to balance. Definite maximum production expected from the tunnel kiln should be decided upon, and plans made to operate the factory accordingly. A tunnel kiln is flexible within certain limits. That is, it may be operated under designed capacity with little loss in efficiency but if pushed much beyond capacity, the ware losses will probably increase and overcome any other advantages gained. Variation should be used only to take care of the unexpected. A tunnel kiln must be designed to meet the requirements of each particular installation. It is essential that maximum capacity requirements be decided upon at first so that the kiln designer may estimate the proper size of kiln needed.

If seasonal demand is an important factor in production planning, then a study of the relation of tunnel kiln capacity to average market and stock requirements will often reveal vital points. In some cases, it would be possible to reduce the amount of the initial investment required and to obtain lower manufacturing costs when operating. For example, a kiln designed for the maximum production of the busy season, would have to operate for only a short time after that period to produce enough ware for stock to last until the next season. This condition means idle equipment with accruing interest and depreciation, a part time labor force, and other manufacturing disadvantages. A smaller kiln operating the year around would meet average requirements and produce enough extra ware for the demands of the busy season. Each case has its advantages and disadvantages and the solution depends entirely upon individual conditions such as initial cost of kiln and factory layout, size of the factory, future expansion plans, interest on money invested in plant and stock carried and the local labor conditions.

The following information concerning the ware which it is planned to fire in a tunnel kiln, should be presented to the kiln designer for consideration. This includes sizes and weights of ware units, general composition and properties of the ware, present firing conditions with attendant problems, and any particular features of peculiarities of the body and ware. Such information together with production data and plant layout will allow a kiln designer to present accurate information concerning a proposed installation. Periodic kiln and tunnel kiln firing are really not comparable, still it is essential that periodic kiln practice be known.

Investigation of Market

A manufacturer intending to purchase a tunnel kiln should make a thorough study of the different designs of tunnel kilns firing his type of ware or a similar product. Though not essential, it is desirable that

samples of his ware be fired in tunnel kilns which have operating temperatures and conditions equal or near to those desired. A test of this type can only be made through the courtesy of another manufacturer who permits tests to be made in his kiln. Because of this and other reasons, it is usually impossible to test the quantity of material that most manufacturers would like to have tested.

In examining different types of tunnel kilns all particular advantages claimed by designers, general characteristics of the different kilns, and the attitude of the owners should be investigated. The high points of such an investigation will be discussed in the following paragraphs.

Determine the percentage of No. 1 ware being produced or, better still, determine the loss in fired product that can be charged to kiln operation. It must be realized that many kiln troubles can be corrected in the manufacturing departments and should be considered in the analysis of results obtained. For comparison, previous or comparative periodic kiln averages should be obtained.

How do the costs of maintaining a tunnel kiln compare with a similar cost of a battery of periodic kilns for equivalent production? Such costs must include those of repairing the kiln structure, replacement of car tops, upkeep of machinery (including cars), and repairs to fuel burning devices such as grates, stokers, or oil and gas burning equipment.

Practically all tunnel kiln users have means of obtaining exact fuel consumption for preparing accurate cost data. The cost of fuel consumed per unit of ware fired in the tunnel kiln should be compared with similar costs in periodic kiln firing taking into account the type of fuel and its costs. Fuel costs should include all charges incurred in delivering the fuel to the kiln and the removing of any waste. Power charges for operating kilns should also be included. Fuel consumption in the tunnel kiln will depend upon the following:

(*a*) Weight of ware fired per unit of time.
(*b*) Specific heat and composition of clay body fired.
(*c*) The finishing temperature of the product fired.
(*d*) The treatment required by the clay body.
(*e*) The efficiency of the different features of the particular kiln in use.

The capacity of a car tunnel kiln and the savings effected determine the return on the investment made in the installation. Tunnel kiln capacity should be figured in units of ware per day and not in cars. The investigator should learn the different capacities which the particular kiln has produced together with results. For comparison, the number of periodic kilns required to produce the capacity of the tunnel kiln should be determined. To do this the following formula may be used.

$$N = \frac{PT}{P_1}$$

In which

N = number of periodic kilns required.
P = daily production of tunnel kiln in units of ware.
P_1 = production of one periodic kiln per firing in units of ware.
T = Average turnover in days for one periodic kiln.

T should include time of setting, firing, cooling, drawing, cleaning, repairing and holidays during which the kiln is idle.

The amount of time taken to fire ware in the tunnel kiln should be compared with the length of the same operation in the periodic kiln. This time should be figured from the finish of setting to the start of drawing the ware. The difference in hours or days for these periods will determine the number of days gained in the turnover of raw material into finished product.

A close study of labor requirements and conditions should be made for comparison and future information. Actual labor includes tasks of setting and drawing of ware, moving kiln cars, cleaning up, actual firing of kiln and supervision. These items will vary, depending upon factory arrangement, car handling equipment, class of labor, amount and type of supervision, the policy of the management, and fuel used in the kiln. Also, the observer should note the amount of labor required to bring the ware to the kiln from drier or machine and to deliver the ware to the stock shed or delivery point.

Since every tunnel kiln installation is designed to produce certain results, only comparative costs of installation can be made of kiln and equipment needed, all of which control the initial cost of a tunnel kiln installation. So when investigating tunnel kilns, the type and size of building required, location of loading and drawing tracks, kiln control apparatus and mechanical handling equipment should be observed, so that all useful features can be considered or improved upon for the proposed installation.

Inquiry should be made as to what particular problems or trouble have been met in operating the particular tunnel kiln; also whether or not adjustment of the kiln itself was sufficient to overcome the trouble.

Problems in Tunnel Kiln Factory Operation

There are several problems that generally present themselves in factories installing tunnel kilns. These problems are not directly connected with the control of the tunnel kiln but concern the labor and management of the plant. A previous knowledge of these problems will hasten their solution when the time comes and thus increase the efficiency of the factory and the kiln.

It should be realized from the beginning, that a tunnel kiln is not a panacea for all the ills of a clay products factory. The tunnel kiln is

a device for producing and controlling a process which, because of its very nature, must be hidden to a relative extent from the operator. Time must be given for the development of the process in the kiln, therefore, the operator cannot expect that, by making a slight change in kiln controls, results will appear immediately. The tunnel kiln of today is as near perfect as present knowledge and experience can make it, yet with each particular kiln some unforeseen problems may arise and a longer period of adjustment than ordinarily necessary may be taken to overcome the trouble. A period of adjustment will always be necessary in starting a tunnel kiln and should be expected when installing a kiln. In other words patience is required.

In some clay products manufacturing plants, some of the organization will very likely think it almost sacrilegious to change any existing process that may have been used for years. Also the advent of a tunnel kiln into a clay plant, just like the entry of any revolutionary machine into an industry, will cause labor to look upon it with dubious eyes. The idea of continuous operation with necessary supervision often discourages those directly in charge of plant operations. Others, either through hearsay, lack of knowledge or experience, predict the failure of the kiln installation and so do not coöperate when the proper time comes. Such points are mentioned because they have been found to exist. It is essential that a manufacturer not only "sell" himself on the tunnel kiln idea but he must instill into his organization the enthusiasm necessary to make the installation a success from the start.

Skilled technical labor is not required to operate a tunnel kiln. A tunnel kiln operator needs only a common school education, a receptive and intelligent mind and habits of punctuality and attention to detail. If the kiln installation is equipped with means for moving the kiln cars along the return track, then one man should be able to place cars of green ware in the kiln, remove the finished ware cars from the kiln and watch the firing, unless coal is used. The men employed to set ware on the kiln cars should be impressed with the necessity of careful and uniform workmanship, because nine out of ten tunnel kiln wrecks can be attributed to carelessness or negligence on the part of the car setters.

There should be at least one man in the organization, preferably one with technical knowledge, who will understand all of the details of the kiln controls and operation and have direct supervision over the kiln and operators. Such a man will be able to make any adjustment of the kiln controls that might be needed at various times. Only a fraction of this man's time should be required to supervise the tunnel kiln and its operation.

The tunnel kiln affords excellent opportunities for a bonus wage system. It is a very simple matter to keep a complete check on each car of ware

and thus be able to place the blame for faulty workmanship. A tunnel kiln probably can be operated by cheap labor to some degree of success, yet common sense should restrain an owner from hiring a two-dollar-a-day laborer to take charge of a piece of apparatus in which is invested thousands of dollars, not only in the structure but in the ware in process through the kiln. Also, it is not good policy to give the fireman so much work that the control of firing is neglected.

It is generally found in tunnel kiln practice that the temperature range through which a particular clay body or glaze is matured, is shorter than in periodic kiln firing. Consequently, a very uniform temperature must be obtained throughout the setting of the ware in the tunnel kiln. Sometimes if trouble develops it is possible to fit a body or glaze to the tunnel kiln by making slight changes in composition and not lose any of the characteristic properties of the body fired. In general, though, a well-designed tunnel kiln has enough flexibility of controls to meet such conditions when they arise.

All the firing troubles of periodic kilns, such as "clay cracks," black-coring, bloating, dunting, soft and over-fired ware, blistering, flashing and "airing," can be encountered even when using a tunnel kiln. Some of these troubles occur when the capacity limits of the kiln have been exceeded, others because proper attention has not been given to the control of the kiln or where the kiln has not been adjusted to meet new conditions that have arisen.

The machinery used to operate the tunnel kiln is in constant service. Special attention should be given this equipment to keep it in good shape. The ordinary wear and tear on continuous-duty machinery should be realized and future replacements anticipated. An accessible stock of vital parts for the machinery equipment is good insurance for continuity of operation.

Conclusion

There have been a number of tunnel kilns built in this country, some failures, some mediocre successes, but the majority of recent installations are real successes. The manufacturer of today who thoroughly investigates the different types of tunnel kilns and then decides upon one whose success is assured by past performance and the reputation of its designers need have no fears as to the ultimate success of his choice.

Carl B. Harrop, Engineers and Constructors
Columbus, Ohio

SCUMMING AND EFFLORESCENCE[1]

By M. E. Reynolds[2]

ABSTRACT

A. **Drier Scum.**
1. Soluble salts.
2. Iron sulphate and pyrite.
3. Sulphur in fuel and the addition of barium salts.
4. Lime bicarbonate.
5. Preheating versus scum.
6. Weathering versus scum.

B. **Kiln Scum.**
7. Sulphur in fuel.
8. Iron sulphide in clay.
9. Alkaline cooling scum.
10. Scum on sewer pipe.

C. **Efflorescence on Fired Ware.**
11. Soluble sulphates in soil.
12. Soluble salts in wall.
13. Rain water.
14. Mortar and adjoining material.
15. Yellow, green and brown spots.

The following is a brief summary of a portion of the literature which has been written on the subject of scumming and efflorescence in brick.

A. Drier Scum

1. The most numerous cases of scum occur in the drier or in the water-smoking period in the kiln and are caused for the most part either by the presence of soluble salts contained in the clay itself, the tempering water, or by the action of the sulphur gases from the fuel on the lime content in the clay. The most troublesome of the soluble salts are the sulphates of lime and magnesia or both together. Evaporation takes place from the surface of the brick, and as each minute portion of water is evaporated, its place is taken by another portion from the interior of the brick. Each small portion of water carries its load of soluble salt and deposits it on the surface of the brick causing a scum, which being about the same color as the dried brick, does not show up until the darker fired color of the ware makes it visible.

2. Many clays contain sulphide of iron (pyrite), which is changed to iron sulphate by the action of air and moisture. This causes a brown scum which would not be objectionable in red firing ware, but the iron sulphate, when it comes into contact with fine limestone, a constituent of some clays, forms lime sulphate which is deposited as a white scum. Most tempering water contains lime sulphate and in this case the sulphur may be present in the water and the lime in the clay. The reaction of the two would deposit lime sulphate on the brick as a scum.

---

[1] Presented to the Pacific Northwest Claymakers' Association, Jan. 17, 1925.

[2] Department of Ceramic Engineering, University of Washington.

3. The burning of coal or other sulphur-containing fuel to heat the drier will cause the evolution of sulphur gases, which unite with the moisture in the drier to form sulphuric acid. If these products of combustion should get into the drier, the resulting acid will attack the lime carbonate in the clay, causing a scum of lime sulphate to be deposited on the ware. In cases where the heat is supplied by waste gases from the kiln the same sulphur gases will be introduced, causing the same scum. Where the heat is supplied by gases from the cooling kiln, the sulphur content in most cases will be negligible.

Where soluble sulphates are the cause of scumming, the addition of barium compounds will in most cases be a remedy. Barium carbonate will, in many instances, do the work, changing the lime sulphate into insoluble barium sulphate and leaving insoluble calcium carbonate.

Table I

Solubilities of Different Salts

One part salt	Parts of water required for solution	One part salt	Parts of water required for solution
Calcium sulphate	495.00	Magnesium chloride	0.60
Calcium carbonate	77,000.00	Barium sulphate	435,000.00
Calcium hydroxide	590.00	Barium carbonate	45,450.00
Calcium chloride	1.37	Barium chloride	3.00
Magnesium sulphate	3.75	Barium hydrate	27.00
Magnesium carbonate	9,400.00	Iron sulphate	3.00

Barium carbonate, being only slightly soluble, will in some cases have insufficient time to react with all the sulphates, in which case, according to Professor Binns, a more soluble form of barium should be used. He says that barium chloride which costs from $72.00 to $76.00 a barrel on the New York market, would be the cheapest because it is soluble in water and therefore distributes itself more thoroughly through the clay, but that it is dangerous, for if a slight excess is used it will cause a scum itself.

A simple method to determine the amount of barium salts necessary to stop the action of the soluble salts in clay is described by Prof. Parmelee as follows: Into each of several small glass jars an equal weight of clay is placed and equal amounts of distilled water added to each sample. The samples are then stirred well. Into one jar is placed a measured quantity of dilute barium chloride solution of known strength, which has been prepared with distilled water. Into a second jar a slightly larger quantity is placed and so on for the remainder of the jars, increasing the quantity in each succeeding jar. The samples are now agitated and allowed to settle. After standing for several hours a small amount of the clear liquid is poured off and if turbid is clarified by filtering or adding a trace of muriatic acid. When clear, a drop of sulphuric acid is added to each sample. If a white cloud forms it is evident that too much barium chloride has been

added. If the fourth sample remains clear upon the addition of sulphuric acid and the fifth sample shows a little white cloudiness, it is plain that the sixth sample contains just a trifle of barium chloride in excess. Knowing the weight of the clay used and the strength of the chloride, it is easy to calculate the exact amount of barium chloride or carbonate which will be sufficient to precipitate all of the soluble sulphates. To find the proper amount of barium carbonate multiply the weight of chloride by 0.80. The carbonate is far less soluble and reacts more slowly so that an excess should be used for quick work. An excess of carbonate will not cause scum, but an excess of chloride will give a chloride scum. Seger advises the use of double the amount calculated. The Germans advise the use of a slightly insufficient amount of barium chloride with an excess of barium carbonate, saying that no trouble will be experienced from this source as the barium carbonate is but slightly soluble and an excess can do no harm. Prof. Binns states further that the action of the barium has nothing to do directly with the lime; all it does is to take possession of any sulphur that may be present so that there is nothing for the lime to combine with to form a soluble salt. The use of barium is also a remedy when the scum is caused by the sulphur from the coal or waste kiln gases, as it sets a trap for the sulphur and no calcium sulphate can be formed. Barium hydroxide has also been used.

4. In the same article, Prof. Binn states, "If carbonic acid is present in the tempering water the lime may be in the form of a bicarbonate, a soluble form of calcium, or in the form known to druggists as lime water. These forms do not in themselves cause troublesome scums, but if the clay contains a large amount of lime a bad scum may appear. The only remedy here is to change the water supply or to doctor the water. The addition of quicklime will precipitate the bicarbonate, but care must be used and the proper amount of quicklime necessary determined by experiment. If an excess is used new lime water may be formed.

5. In the case of highly colloidal sticky clays, soluble salts may be absorbed by the clay. When these clays are preheated to reduce shrinkage, the plasticity is reduced and the clay will release some of the soluble salts which will come out in the drier and cause scum.

6. Weathering clay will in some cases tend to reduce scum and in other cases to increase it. Highly soluble salts such as ferrous sulphate will be washed out of the clay in the process of weathering by rain water. On the other hand, if clays which are high in iron pyrite are weathered the pyrite will be changed by the action of air and moisture into iron sulphate which will come out later as drier scum.

Slow drying facilitates the formation of scum, while rapid drying tends to prevent it by holding the sulphate inside of the product. Open porous structures are less liable to show drier scum than dense ones, as the soluble

salts are deposited in the body of the ware or on the walls of the pores. Rough texture brick are less affected by scum than smooth ones for the surface of the brick has a larger area on which the scum is deposited, and the effect is diluted. In rough brick variation is wanted, and slight scum would not be detrimental, for in some cases it might give exactly the desired effect.

B. Kiln Scum

7. All coal contains sulphur and, when burned, sulphur gases are evolved, which uniting with the moisture remaining in the brick forms sulphuric acid. This acid attacks the carbonate and other calcium salts to form sulphates which are deposited on the ware as scum, the same as drier scum. This scum is stable except under reducing conditions, therefore the atmosphere of the kiln should be kept in as good a reducing condition as the structure and fired color of the ware will permit.

8. The iron sulphide (pyrite) in the clay is decomposed at 750°C while the sulphuric acid is volatilized at 680°C. During the early part of the firing the temperature in the upper part of a down-draft kiln may be high enough to decompose the pyrite and liberate sulphur, while the lower part of the kiln is at a temperature below that of the volatilization of sulphuric acid. The liberated sulphur will unite with the moisture, forming sulphuric acid. The action of the acid is to decompose the carbonates of lime and the feldspars forming the sulphates, which are deposited as scum on the brick in the lower part of the kiln. The best remedy for both of the preceding cases would be to heat the kiln to 680°C with wood or some non-sulphur containing fuel. This heating should be done under oxidizing conditions as the sulphur in the pyrite is not released as easily under oxidizing, as under reducing conditions. By driving off the moisture in this way and then using clean dry fuel, no sulphuric acid can be formed and scum from this cause will be eliminated.

Wet brick set in the kiln are more apt to scum than dried brick as the evaporation of water in the brick retards their heating and affords a good place for the condensation of the sulphuric acid. The acid diffuses through the brick forming sulphates which are carried to the surface and deposited.

9. A whitish coating is sometimes found upon brick after opening the kiln, especially upon those near the door, or appearing soon after removal from the kiln. This scum, which analysis shows to be composed chiefly of sodium sulphate with sodium chloride, a little calcium sulphate and no magnesium sulphate, is readily removed by washing. The probability is that the scum was formed during the cooling of the kiln, otherwise the sodium chloride, at least, would have been volatilized. The source of the sodium is probably from the ashes and clinker in the cooling fireboxes and the sulphur for the sulphate from the same source. To pre-

vent the occurrence of this scum the fire-boxes should be cleaned when the firing has been completed and before the cooling starts.

In some cases a brown scum may be produced with iron salts which will give a polychrome effect of irregular lines on buff and red fired ware. There is a field for future work in developing polychrome color schemes by artificial addition of iron salts.

10. A white scum is often found on sewer pipe a short time after they are removed from the kiln, and is due to excess salt fumes in the kiln atmosphere, which had not been drawn off at the stack, but were redeposited on the ware. The first heavy rain will wash it off; or a light fire may be used to burn it off after the salting has been completed.

C. Efflorescence on Fired Ware

The staining or scumming of brick after they are removed from the kiln to the yard, and after they are set in the wall is generally spoken of as efflorescence. It is very troublesome and is caused in several different ways. The remedies have not been very thoroughly studied.

11. Many brickyards use the ashes and clinkers for filling in around the yard, and the soil becomes saturated from the soluble salts being washed from the clinker. If brick are piled on this ground, they will absorb the salts from the soil. Later these will be leached out and appear as efflorescence, chiefly at the bottom of the pile. The ground should be paved with hard brick or plank laid under the pile.

12. Efflorescence may be caused by the gradual leaching out of some soluble sulphates left from the firing and also from the breaking down of silicates and a combination of the bases with sulphuric acid from the atmosphere, or from the remaining pyrite in the ware. The most common constituent of this efflorescence is the sulphate of calcium which is not dissociated until the temperature in the kiln reaches 1200°C (2192°F). In some cases it may be formed by magnesium and alkali sulphates if the brick are low fired. If the ware is hard fired all these sulphates are decomposed and taken up into silicate formations and therefore become harmless.

13. Efflorescence is often produced after a heavy storm by the rain water, which enters the brick and mortar and upon evaporating carries to the surface some of the soluble salts. This coating is usually washed away by the next rain, although sometimes it may remain collected in blotches. A solution of muriatic acid will remove the blotches and if it occurs frequently the brick may be coated with paraffine or linseed oil. This will make them darker, but will also make them impervious to the rain water.

14. Many cases of efflorescence are not due to any fault of the brick but can be laid to the mortar, which may contain soluble salts of mag-

nesium, calcium, sodium and potassium. Rain soaking into the jointing material carries the soluble salts over the faces of the brick thus discoloring them. Also when lime mortar is used, calcium hydroxide is formed. This compound is almost as soluble as the sulphate, which is one of the main causes of drier scum. When laid in wet weather the wall will be soaked with water which will carry the salt to the surface where it evaporates. It will then combine with the carbon dioxide in the air to form calcium or lime carbonate. This will wash off readily in the next rain but may reappear due to the slowness of the reaction in the interior of the wall.

The use of sandstone decoration on brick buildings is the cause of much discoloring of the brick, for the sandstone is, in many cases, impregnated with soluble salts, which are leached out and run down on the brick, discoloring them, and in some cases being leached through the brick. The use of a thin sheet of copper under all stone courses, with the edge projecting and turned down to form a drip, would eliminate this scum.

15. Efflorescence in the form of yellow, green and brown spots may be due to several agencies. Occasionally it is caused by the growth of some low vegetable organism which takes its nourishment from the brick and the air. In one case investigated by Seger, the spots were found to be due to chromium compounds. In a good many cases the spots were caused by vanadium, in the form of vanadic acid, and occurs mostly on the underfired brick. This may be remedied by firing the kiln to a higher temperature, and in such a way that the kiln is periodically filled with a reducing atmosphere. The chemistry of the reaction is that the soluble vanadic compounds are reduced to insoluble vanadous oxide and fixed by fusion at the higher temperature with the silicates. The spots might also be caused by the presence of some soluble iron salts which were not fused in the firing. The chemistry of iron salts and colors has not been thoroughly investigated but it is suspected that some terra cotta cleaned with muriatic acid will develop yellow spots of iron chloride.

Experimental work should be done in local sands, mortar, lime and Portland cement to determine their content of soluble salts.

Bibliography of Scumming and Efflorescence[1]

1. C. W. Parmelee, "Soluble Salts in Clay Wares," *Brick and Clay Record*, August 22, 1922, p. 249; and p. 316, Sept. 5, 1922.

2. Charles F. Binns, "Efflorescence and How to Stop It," *Brick and Clay Record*, p. 1017, Nov. 18, 1913.

3. Arthur E. Williams, "How to Prevent Efflorescence in Finished Brickwork," *Brick and Clay Record*, p. 341, Sept. 7, 1915.

[1] See also F. G. Jackson, "A Descriptive Bibliography of Scumming and Efflorescence," *Bull. Amer. Ceram. Soc.*, **4** [8], 376–401 (1925).

4. "Scumming, Efflorescence and Whitewash," *Brick and Clay Record,* p. 602, April 18, 1922.

5. "Collected Writings of Hermann A. Seger," p. 396. "On Barium Compounds as an Addition to Clay in the Manufacture of Face Brick."

6. "Collected Writings of Hermann A. Seger," p. 381. "Yellow and Green Efflorescence on Brick Fronts."

7. "Collected Writings of Hermann A. Seger," p. 369. "The Influence of the Sulphur in Coal upon Clay Wares."

8. "Collected Writings of Hermann A. Seger," p. 376. "A Contribution to the Knowledge of Efflorescence on Terra Cotta."

9. J. C. Jones, "Efflorescence of Brick," *Trans. Amer. Ceram. Soc.*, **8**, 369(1906).

10. Ellis Lovejoy, "Scumming and Efflorescence," The Lovejoy Eng. Co., Columbus, Ohio.

11. F. G. Jackson, "The Behavior of Calcium Compounds in Clay," *Jour. Amer. Ceram. Soc.*, **7**, 427(1924).

12. C. W. Parmelee, "Soluble Salts and Clay Wares," *Jour. Amer. Ceram. Soc.*, **5** [8], 538(1922).

13. M. E. Gates, "A Satisfactory Method of Using Barium Hydrate in Terra Cotta Bodies," *Jour. Amer. Ceram. Soc.*, **3**, 313(1920).

WHAT IS THE EFFECT OF TANK CONDITIONS ON SELENIUM COLOR?[1]

By R. R. Shively

It is impossible to determine the amount of selenium actually necessary for decolorization. The average amount used in the batch is less than one part in 80,000 parts of finished glass and, as some of this is lost by volatilization or oxidation, it is quite impossible to find by analysis the amount of selenium remaining in the finished glass.

A few manufacturers do not use arsenic and the amount of selenium required for their batch is unusually small. I know of one factory where raw materials of low iron content are used that required but 0.125 ounce of selenium combined as a selenite to decolorize a thousand pounds of sand. Another factory not using arsenic requires but 0.25 ounce of selenium for one thousand pounds of sand. Where the average amount of arsenic is used (two pounds to the thousand of sand) the amount of selenium required to the batch is about 0.5 of an ounce. Where a selenite is used even a smaller quantity is required. It can be seen from the above facts that very little selenium is required for decolorization and if any unusual amount of it is lost through furnace conditions it would seriously affect the color.

Selenium melts at 217°C. It burns in the air with a bluish red flame forming selenium dioxide, and boils at 690°C. From these properties it would be expected that some of the selenium introduced in the furnace is

[1] Presented at the Annual Meeting, American Ceramic Society, Feb., 1925. (Glass Division.)

lost by volatilization and, in the case of a tank operating under oxidizing conditions, some of the selenium may combine with oxygen and the selenium dioxide carried out with the stack gases.

Let us consider for the time ruby glass where a much larger amount of selenium is used. Ruby batches made in pots require much less selenium than those made in tanks. In the latter case I am informed that everything depends upon the flame. A certain batch may give a good glass one day and the next melt may be unfit for use. The fumes of selenium can be seen escaping from the tanks. If where larger amounts of selenium are used the operation of the furnace is so important it certainly has its influence in a lesser degree where small quantities are employed.

It has been my experience that the hotter the tank is run the less selenium is required for decolorization. This may be explained by the fact that where high temperatures are obtained, the furnace is being operated efficiently and a neutral condition is maintained within the furnace.

Unquestionably tank conditions affect to some extent selenium decolorization. Constant temperatures and uniform furnace conditions must be maintained in order to get the best results.

M. F. Curtis: Do you know whether selenium is introduced in any other form besides metal and selenite?

R. R. Shively: No, the only form of selenium being sold here is the amorphous, known as metallic and sodium selenite. There is a very small amount of red selenium coming into this market. It is very finely powdered and I am informed that it is not satisfactory. It is a little cheaper but it requires so much more to get results.

M. F. Curtis: Do you know any reason why it is not possible to use selenite of soda?

R. R. Shively: There is no sodium selenite used. The selenites are a little harder to prepare. It is rather expensive.

A. R. Payne: Some have said that in the leers the pinkness of a selenium decolorized article is higher in the back end of the leer than at the front of the leer.

Our experience has been absolutely contrary to this. We always have a slight fading or a burning out of the high color after leaving the machines. Of two tumblers made consecutively we can always tell which one has been through the leer and which one has not. The one that has not been through the leer is of high color while the one that has been through the leer is just right. We have to regulate it according to what is at the back end of the leer.

R. R. Shively: May I ask if you use any manganese color in your glass?

A. R. Payne: No.

R. R. Shively: I have seen the condition you speak of occurring where they use manganese coloring along with the selenium but you are the

only place of all the factories I have visited that has not at some time run into red glass in leers. The glass will be perfectly good color when it goes in the leers. The leer adjacent may be a little hotter. The glass ware on that side will turn perfectly pink. I have seen the glass on either side of the leer pink and that in the middle a little low in color.

There is one particularly odd thing I saw. An open leer was leaking a little bit at the muffle, a little flame was shooting out. It was an old hand-operated leer. They would pull this leer one pan at a time and about every two feet a half dozen jars would be absolutely pink where the flame was. This was the first time I noticed this and I thought they were gathering red and green glass out of the same hole.

A. SILVERMAN: Dr. Shively, have you run across any samples of selenium adulterated with tellurium and have you noticed any perceptible effects in glass?

R. R. SHIVELY: We analyze every shipment of selenium we get and in practically all cases we find a small amount of tellurium present but rarely over 0.2% or 0.3%. I might say in this connection that selenium analyzes approximately 99% selenium and I have never found tellurium added as an adulterant.

M. F. CURTIS: Do you know of anyone treating metallic selenium with concentrated sulphuric acid before it is added to the batch to get a ruby glass?

R. R. SHIVELY: I have never heard of that. There are certain manufacturers of ruby glass who use a selenite but most of them use the metallic selenium.

M. F. CURTIS: You get a selenite by treating with concentrated sulphuric acid. I know one place where that is being done. I was not able to determine the reason.

H. L. DIXON: While this discussion is on I wonder if anybody can tell why manganese was used from time immemorial as a decolorizer and it took a world war to get them out of that rut and start them on selenium.

You know one of the hardest things in making flint glass in a tank with manganese was the absence of color. The manganese is so susceptible to atmospheric conditions in the furnace. Now that has all been passed up and they use selenium almost universally and I have often wondered since selenium was available before why somebody had not used it.

R. R. SHIVELY: The first selenium that came to this country was brought over by Mr. Nicholkopf who made ruby glass in 1894. That selenium cost $28 a pound. Until a few years ago selenium was rather hard to get. It was expensive. Today there is being marketed in this country approximately 15,000 pounds of selenium a month, and I am told in the refineries that they are refining lower grades all the time in order to

get the output. The company that I represent has had in the early days of selenium as much as 50,000 pounds of selenium in storage at one time and at the price it was at that time it represented quite a little money. That was before selenium became so generally used.

Today our shipments are right up to production. We have trouble at times to keep production going. It was not used more because it was very expensive. A good deal of work had been done in Germany with it as a decolorizer, but it was not taken here seriously until we were forced to it. The old saying, "Necessity is the mother of invention," applies here.

A. R. PAYNE: This is a case where a man patented something 25 years too soon. I think the German patent on this use of selenium came out about 1894.

ACTIVITIES OF THE SOCIETY

R. C. PURDY TO REMAIN IN OFFICE OF GENERAL SECRETARY OF THE AMERICAN CERAMIC SOCIETY

It is with pleasure that the Board of Trustees announces that Ross C. Purdy, on request by the Board and several members, has reconsidered and withdrawn his resignation as Secretary of this SOCIETY as reported in the June *Journal.* This decision will be welcomed by all members of the SOCIETY.

Mr. Purdy's success as Secretary of the SOCIETY and as Editor of the *Journal* is recognized within and without the SOCIETY and his demonstrated ability in these offices, together with his real interest in the affairs of the SOCIETY makes a rare combination for which the SOCIETY may well be thankful. Let us all in word and action give united support to Secretary Purdy in his editorial and secretarial work.

E. WARD TILLOTSON, *President*

AMERICAN CERAMIC SOCIETY ANNUAL MEETING

Atlanta, Ga., February 8-13 Inclusive

(Headquarters—Hotel Biltmore)

Seven meetings in one—Art, Enamel, Glass, Heavy Clay Products, Refractories, Terra Cotta and White Ware.

Technical sessions through to Thursday noon and then a trip through Wilkinson County from Macon, Gordon, McIntyre and Stevens Pottery, starting Thursday noon and continuing through Saturday.

A "cut-up" evening on Tuesday with the Woman's Club of Atlanta as hostess, a banquet Wednesday evening with sparkling southern wit and entertainment, an auto-lunch box picnic trip to Stone Mountain Thursday noon, a special train to Macon and a complimentary dinner, a barbecue Friday noon at Gordon and a lunch and golf in Macon Saturday afternoon are the social affairs.

Clay mines and clay plants will be visited.

A big exhibit will be shown in the store and sample rooms of Hotel Biltmore.

One and one-half fare on certificate plan has been granted by the several passenger associations. Here are the fares one way from several points. Note that the numbers on the map and in the following table correspond. This will show that it will cost no more to get to Atlanta than to other meeting places.

1. Chicago **Fare $26.72** **Lower Berth $8.25**	Chicago and Eastern Illinois trains leaving Chicago 11.55 A.M., 12.25 P.M. and 9.45 P.M.; Pennsylvania R. R. train 9.15 P.M. and Big Four trains at 10.10 A.M., 1.00 P.M., 9.15 P.M. and 11.40 P.M. carry through sleepers with dining service to Atlanta.
2. Detroit **Fare $26.68** **Lower Berth $8.25**	Michigan Central train, "The Flamingo," leaving Detroit at 12.20 P.M. is a through train to Atlanta. Through sleepers and dining service on train leaving at 12.50 P.M.
3. Cleveland, Ohio **Fare $26.45** **Lower Berth $8.25**	Through sleepers and dining service Cleveland to Atlanta on Big Four trains leaving Cleveland 12.00 noon and 3.45 P.M.

4. Columbus, Ohio
Fare $21.61
Lower Berth $5.63

Big Four trains leaving Columbus 3.15 P.M., "The Flamingo," and 7.05 P.M., "Suwanee River Special," go through to Atlanta. Or, use any train to Cincinnati and through trains from there. See No. 5.

---

5. Cincinnati
Fare $17.30
Lower Berth $4.50

Louisville and Nashville trains leaving Cincinnati 6.27 A.M., 7.00 P.M. and 8.00 P.M., and Southern Railway trains leaving at 8.50 A.M., 6.45 P.M. and 9.50 P.M. are through trains with dining service to Atlanta.

---

6. Indianapolis
Fare $20.47
Lower Berth $5.63

Pennsylvania R. R. leaving Indianapolis 10.00 P.M. and Big Four leaving at 6.15 P.M. carry through sleepers with dining service to Atlanta. Or, use any train to Cincinnati and through service from there. See No. 5.

---

7. Pittsburgh
Fare $28.49
Lower Berth $8.63

Use any convenient train to Cincinnati and through trains from there. See Nos. 4 and 5.

---

8. Washington, D. C.
Fare $27.91
Lower Berth $7.50

R. F. and P. trains leaving Washington 8.50 A.M. and 6.35 P.M. and Southern Railway trains at 12.20 A.M. (sleeper open 10.00 P.M.), 11.00 A.M., 3.45 P.M., 9.35 P.M. and 10.50 P.M. carry through sleepers and dining service to Atlanta.

---

9. Baltimore
Fare $29.35
Lower Berth $7.50

Trains leaving Baltimore over Pennsylvania R. R. at 6.03 A.M., 2.20 P.M., 8.06 P.M. and 11.05 P.M. have through sleepers and dining service to Atlanta.

---

10. Philadelphia
Fare $32.81
Lower Berth $8.63

Pennsylvania R. R. trains leaving Philadelphia 12.13 P.M., 5.48 P.M. and 8.47 P.M. have through sleepers and dining service to Atlanta.

---

11. Harrisburg
Fare $30.34
Lower Berth $10.13

Take Pennsylvania R. R. to Baltimore or Washington and through trains from those points. See Nos. 8 and 9.

---

12. Trenton
Fare $29.07
Lower Berth $9.75

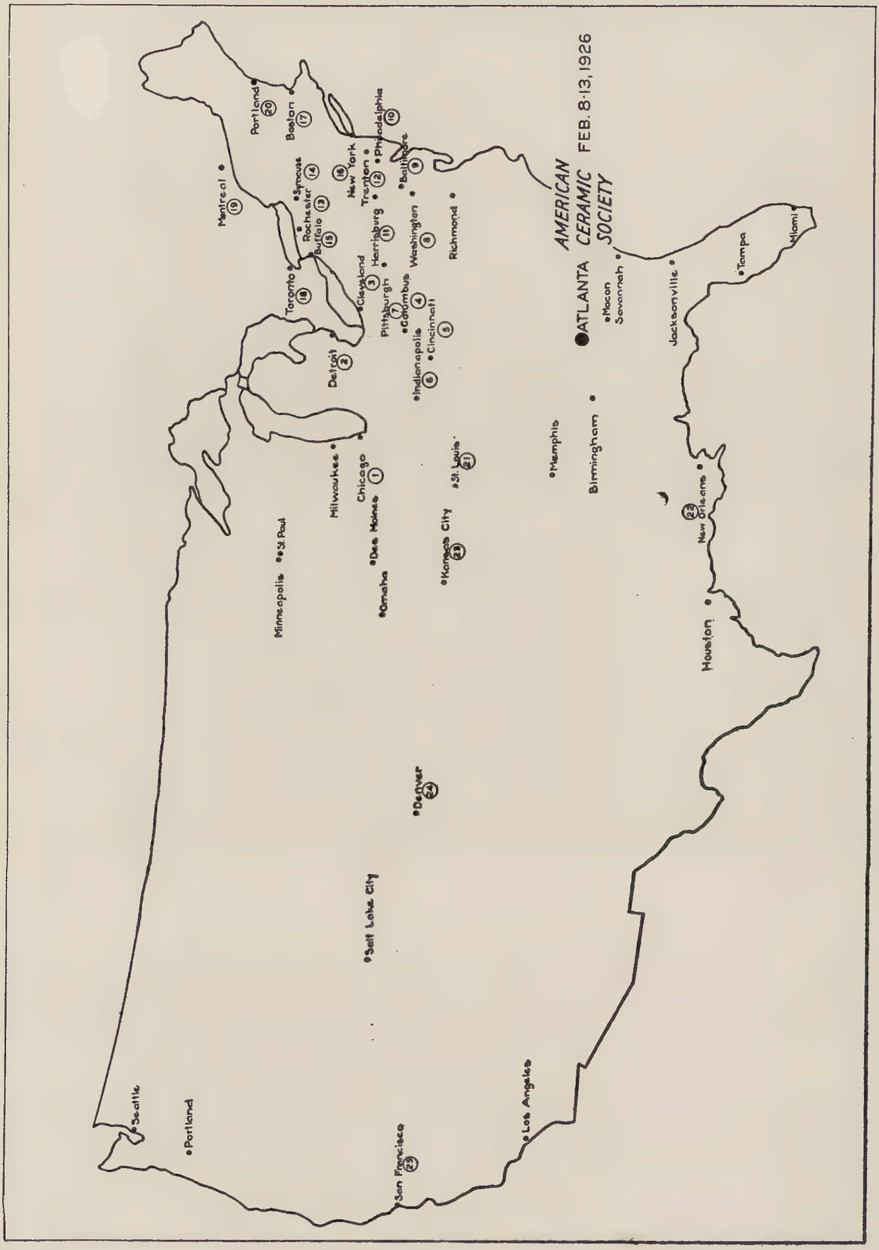
Pennsylvania R. R. trains leaving Trenton 11.26 A.M., 4.58 P.M. and 8.00 P.M. carry through sleepers and dining service to Atlanta.

---

13. Rochester
Fare $44.46
Lower Berth $12.00
Fare $35.49
Lower Berth $12.00

Use New York Central or Lehigh Valley to New York City and through trains from there to Atlanta. See No. 16 or

Use New York Central and Big Four via Cincinnati. See 3, 4 and 5.


AMERICAN
CERAMIC
SOCIETY
FEB. 8-13, 1926
ATLANTA
Seattle
Portland
San Francisco
Los Angeles
Salt Lake City
Denver
Minneapolis
St. Paul
Omaha
Des Moines
Kansas City
St. Louis
Milwaukee
Chicago
Memphis
Birmingham
Houston
New Orleans
Jacksonville
Tampa
Miami
Macon
Savannah
Detroit
Indianapolis
Cincinnati
Columbus
Pittsburgh
Cleveland
Toronto
Buffalo
Rochester
Syracuse
Montreal
Portland
Boston
New York
Trenton
Philadelphia
Baltimore
Harrisburg
Washington
Richmond

14. Syracuse **Fare $38.38** **Lower Berth $12.00** **Fare $41.56** **Lower Berth $12.00**	Use New York Central and Big Four via Cincinnati. See 3, 4 and 5 or Use through service on Lackawanna or New York Central to New York and Philadelphia and through trains to Atlanta from those points. See 10 and 16.
15. Buffalo **Fare $35.86** **Pullman 12.00** **Fare $33.01** **Lower Berth $12.00**	Through service to Atlanta through Philadelphia or Washington on Pennsylvania. See 8 and 10 or Through service over New York Central via Cincinnati. See 5.
16. New York City **Fare $31.11** **Lower Berth $9.75**	Pennsylvania R. R. leaving New York 12.45 A.M. (sleeper open 10.00 P.M.), 10.10 A.M., 3.40 P.M. and 6.40 P.M. Through sleepers and dining service to Atlanta.
17. Boston **Fare $40.27** **Lower Berth $12.38**	New York, New Haven and Hartford through trains to New York and Washington and through trains from those points to Atlanta. See Nos. 8 and 16. Train leaving Boston 9.00 A.M. carries through sleeper to Atlanta.
18. Toronto **Fare $36.68** **Lower Berth $12.00**	Canadian National and Canadian Pacific operate through service to Cleveland or Detroit. Through trains from those points to Atlanta. See Nos. 2, 3 and 5.
19. Montreal **Fare $46.02** **Lower Berth $15.00**	Use Canadian National or Canadian Pacific through trains to New York or Washington. Through trains from those points to Atlanta. See Nos. 8 and 16.
20. Portland, Me. **Fare $44.19** **Lower Berth $15.00**	Take parlor or sleeping car over Boston and Maine to Boston or New York and through service to Atlanta from those points. See Nos. 16 and 17.
21. St. Louis **Fare $22.53** **Lower Berth $6.75**	Louisville and Nashville trains leaving St. Louis at 8.44 A.M., 2.00 P.M., 3.36 P.M., 9.25 P.M. and 11.30 P.M. (sleeper open 9.00 P.M.) carry through sleepers with dining service to Atlanta.
22. New Orleans **Fare $17.78** **Lower Berth $5.63**	Louisville and Nashville trains leaving New Orleans 8.30 A.M., 5.00 P.M. and 10.00 P.M. carry through sleepers with dining service to Atlanta.
23. Kansas City **Fare $32.57** **Lower Berth $9.00**	Frisco Line trains leaving Kansas City 9.00 A.M. and 6.00 P.M. carry through sleepers with dining service to Atlanta. Or, use any train to St. Louis and through trains from there. See No. 21.

24. Denver
Fare $55.25
Lower Berth $15.38

Rock Island train leaving Denver 9.15 P.M. carries through sleeper with dining service to Atlanta. Or, use any train to Kansas City or St. Louis and through service from those points. See Nos. 21 and 23.

---

25. San Francisco
Fare $82.83
Lower Berth $26.25

Use any train to Chicago, St. Louis, Kansas City or New Orleans and through service from those points. See Nos. 1, 21, 22 and 23. Southern Pacific trains leaving San Francisco 4.50 P.M. carry through tourist sleeper to Atlanta. Tourists sleeping car rate $13.13.

NEW MEMBERS RECEIVED FROM OCTOBER 15 TO NOVEMBER 15

Personal

J. Newton Barnes, P. O. Box 355, Macon, Ga., Secy.-Treas., J. S. Schofield's Sons Co.
Marion Luther Brittain, President, Georgia School of Technology, Atlanta, Ga.
Joseph F. Butler, Box 135, Hoboken, N. J.
Henry Graham Carmichael, 2117 Reading Rd., Cincinnati, Ohio, Pres., Cincinnati Tile and Pottery Co.
Lorenzo S. Cope, 2440 E. 75th, Cleveland, Ohio, Mechanical Engineer, The National Screw & Manufacturing Co.
Harvey Willard Culp, Lab. Asst., Babcock and Wilcox Co. Lab., East Liverpool, Ohio.
Robert Earl Evans, Vice-Pres., Georgia White Brick Co., Gordon, Ga.
Frederick P. Golding, Manager, Golding Sons Co., Butler, Ga.
Jack U. Gould, 710 E. 14th St., New York City, Asst. in charge of Lab., Eagle Pencil Co.
George Guthrie, 61 Mungalhead Rd., Falkirk, Scotland, Technical Chemist.
Orris F. Houk, Gen. Mgr., The Central Refractories Co., New Lexington, Ohio.
Clayton S. Houpt, 5661 Natural Bridge Ave., St. Louis, Mo., Supt., Enamel Dept., Wrought Iron Range Co.
Leander R. Kirk, Cambridge Sanitary Mfg. Co., Cambridge, Ohio.
William C. Koch, Treas. and Gen. Mgr., Twin City Brick Co., 514–19 Pioneer Bldg., St. Paul, Minn.
Chi-fang Lai, Box 233, Station A, Ames, Iowa, Graduate Student.
Stewart J. Lloyd, Prof. of Chemistry, Univ. of Ala., Consulting Chemical Engineer and Geologist, Tuscaloosa, Ala.
Arthur B. Long, Westfield Clay Products Co., Westfield, Mass.
Thomas B. McCoun, Box 578, Lexington, Ky., President and Gen. Mgr., Bybee Pottery Co., Inc.
E. L. Miller, Manager, Nivison Weiskopf Co., Reading, Ohio.
Howard M. Parkhurst, 2728 Boone St., Ames, Iowa, Student.
Edwin B. Streater, 2120 Lincoln Way, Ames, Iowa, Student.
David Thomason, % Edwards and Ames, 619 Pacific Bldg., Vancouver, B. C.
Clifton W. Walters, Supt., Farber Fire Brick Co., Farber, Mo.
David McKay Webster, Chemist and Asst. Mgr., Enameling Dept., Gowanbank Iron Works, Falkirk, Scotland.
Frank C. Westendick, 52 W. Blake Ave., Columbus, Ohio.
Robert A. Whitfield, The Hegeler Zinc Co., Danville, Ill., Chemist.

CORPORATIONS

Farber Fire Brick Co., A. S. Zopfi, Secy.-Treas., Farber, Mo.

Kreischer Brick Mfg. Co., Face Brick Mfrs., Box 135, Hoboken, N. J. J. F. Butler, Representative.

Queen's Run Refractories Co., Inc., Lock Haven, Pa. Geo. H. Diack, Gen. Mgr.

Membership Workers' Record

	Personal		Personal	Corporation
F. E. Allen	1	F. H. Norton	1	
P. E. Cox	1	R. H. Pass	1	
W. B. Cleverly	1	A. Silverman	1	
E. A. Eigenbrot	1	N. Stein	1	
H. W. Harrington	1	A. S. Zopfi	1	1
A. V. Henry	1	C. B. Young	1	
W. K. McAfee	1	Office	9	2
J. M. Mallory	2		—	—
J. M. Manor	1		26	3
D. A. Moulton	1			—
			TOTAL	29

MEMBERSHIP RECORD FOR 1925

	PERSONAL		CORPORATION	
	1924	1925	1924	1925
January	31	24	6	1
February	40	19	8	2
March	29	35	..	6
April	35	9	3	1
May	25	15	4	3
June	18	15	2	2
July	14	15	3	..
August	9	12	..	1
September	9	9	..	2
October	17	14	2	1
November	11	26	2	3
TOTAL	238	193	30	22
December	11		..	
TOTAL	249		30	

We are listing the names of the membership workers for 1925 (up to November 15). Whether you see their names on membership committees or not they are functioning actively in membership solicitation for the AMERICAN CERAMIC SOCIETY. C. F. Geiger of Carborundum Company, Perth Amboy, N. J., has membership honors with five personals and two corporations. Dr. Silverman of the University of Pittsburgh runs a close second with five personals and one corporation. W. L. Shearer and R. A. Weaver are tied for third place with five personal memberships each.

F. E. Allen, 1 P.
C. E. Bales, 2 P.
L. E. Barringer, 2 P.
M. F. Beecher, 1 P.
A. V. Bleininger, 1 P.
C. F. Binns, 1 P.
G. A. Bole, 1 P.
M. W. Butler, 1 P.
W. B. Cleverly, 1 P.
P. E. Cox, 2 P.
H. E. Davis, 1 P.
Dover Fire Brick Co., 1 P.
E. A. Eigenbrot, 3 P.
K. H. Endell, 1 P.
R. F. Ferguson, 2 P.
G. A. Forbes, 1 P.
D. H. Fuller, 1 P.
C. F. Geiger, 5 P., 2 C.
R. F. Geller, 1 P.
R. E. Gould, 1 P.
M. C. Gregory, 1 P.
J. E. Hansen, 1 P.
H. W. Harrington, 1 P.
H. C. Harrison, 1 P.
C. B. Harrop, 1 P., 1 C.
F. A. Harvey, 1 P.
A. V. Henry, 1 P.
L. C. Hewitt, 2 P.
B. M. Hood, 1 P.
R. A. Horning, 1 P., 2 C.
M. R. Hornung, 1 P.
H. A. Huisken, 1 P.
R. K. Hursh, 1 P.
F. G. Jackson, 1 P.
R. W. Jones, 1 P.
R. B. Keeler, 2 P.
S. M. Kier, 2 P.
W. A. King, 1 P.
C. J. Kirk, 1 P.
H. J. Knollman, 3 P.
R. D. Landrum, 1 P., 1 C.
W. K. McAfee, 2 P.
S. J. McDowell, 2 P.
J. M. Mallory, 2 P.
J. M. Manor, 1 P.
P. Marson, 1 P.
H. W. Mauser, Jr., 1 P.
C. R. Minton, 1 P.
D. A. Moulton, 2 P.
W. A. Mudge, 1 P.
F. H. Norton, 1 P.
W. G. Owen, 1 P.
C. W. Parmelee, 1 P.
R. H. Pass, 1 P.
E. P. Poste, 1 P.
W. D. Richardson, 1 P.
F. G. Roberts, 1 P.
W. L. Shearer, 5 P.
Mary G. Sheerer, 2 P.
R. R. Shively, 1 P.
A. Silverman, 5 P., 1 C.
George Simcoe, 1 P.
I. E. Sproat, 1 P.
H. F. Staley, 1 P.
A. Stein, 2 P.
N. Stein, 1 P.
F. L. Steinhoff, 1 P.
E. W. Tillotson, 3 P.
E. J. Unger, 1 P.
E. J. Vachuska, 1 P.
B. F. Wagner, 1 P.
A. S. Walden, 1 C.
P. H. Walker, 1 P.
R. A. Weaver, 5 P.
H. Wilson, 1 P.
H. G. Wolfram, 1 P.
F. C. Woodside, 1 P.
A. S. Zopfi, 1 P., 1 C.
C. B. Young, 1 P.

Footnote: P = Personal Membership; C = Corporation Membership.

ALLOCATION OF CERAMIC WORK IN FEDERAL BUREAUS

Resolutions

Adopted by the Board of Trustees of the American Ceramic Society, being an expression of the views of its members based on their understanding of the present allocation of ceramic work in the federal bureaus:

WHEREAS:

1. For purposes of economy and efficiency the Bureau of Mines and the Mineral Resources Division of the U. S. Geological Survey have been transferred from the Department of the Interior to the Department of Commerce; and

2. Both the Bureau of Standards and the Bureau of Mines have extensively equipped ceramic laboratories and have organized ceramic research personnel, each for distinctly different purposes, with different viewpoints and different methods; and

3. The work of the Bureau of Standards primarily is standardization and specification of properties, qualities and form of ceramic materials and products, and simplification in products, which work is extensive in scope and is needed by the industries and is possible of prosecution only in a central national laboratory representing alike the interests of producers and users of ceramic materials and products; and

4. Incidental to the studies on known ceramic materials and products there is need for determinations of fundamental facts and data, which determinations can most effectively be made by those who are working on specifications and standardization and in a central national laboratory such as the Bureau of Standards, where collaboration of investigating scientists in allied lines may readily be obtained; and

5. The Bureau of Mines has laboratory facilities and systems for plant investigations by field stations in the mining, beneficiation and utilization of ceramic minerals and other materials of the earth now used or possible of use, which investigations are of importance to all ceramic industries alike and to the nation's progress generally, because of the use of ceramic products in most of the nation's manufacturing; and

6. The beneficiation and industrial possibilities of ceramic raw materials and especially the finding of materials which will give greater economy in the industries and homes can best be done through field stations, unified and coördinated through a national research organization which represents alike the interests of, and which can work in close coöperation in the field with, the land owners, miners, producers and prospective users; and

7. The distinctive work done by the Bureau of Standards and the Bureau of Mines, with little overlap or duplication, on products and materials respectively, has been kept separate because of the inherent differences in the character of the problems and in the methods and the facilities for making industrial application rather than because of a desire to have two national bureaus engaged in ceramic research; and

8. Work on standardization and specification of products and of the fundamental studies incident thereto by the ceramic division of the Bureau of Standards can most effectively be done in a central laboratory for it does not relate to processing; and

9. The work of the Bureau of Mines has been of such a character that it has been found effective to employ field stations (permanent and temporary) and laboratory cars thus economically, on a production scale, proving in plants of producers and consumers the availability and best methods of using materials; and

10. Empirical or laboratory scale trial production can be trusted only as indicative and rarely as final evidence of the availability and best method of using ceramic materials, hence the type of investigations that have been made by the Bureau of Mines could not have been so successfully made and proved in a central national laboratory; and

11. A single firm or group of manufacturers is not willing alone to finance such development work and plant proving as has been done by, and in coöperation with, the Bureau of Mines except that the information obtained be kept secret and not made available to ceramic manufacturers generally; and

12. There are so many uses of materials and methods of processing which are of equal value directly to all kinds of ceramic manufacturing and indirectly to the manu-

facturers who are dependent on ceramic materials that it is in the interest of national economy and industrial progress generally that a national bureau shall be conducting researches and proving its findings in the field and in the plants and making public the facts discovered; and

13. State universities throughout the nation have provided and to a larger extent will provide buildings, fixed equipment, light, heat, power and maintenance, and will make available the use of their several laboratories which are as diversified and as well equipped as a national central laboratory would be, and these universities make possible the collaboration of scientists and technologists from their instructional and research staffs, and provide graduate student fellowships, which annual expenditure in the case of Ohio State University now amounts to over $10,000; and

14. The maintenance of field stations by the federal government jointly with state universities in districts where ceramic materials occur or where they have the largest probable industrial use is in accordance with Secretary Hoover's idea of encouraging the several states to assume the cost burden of their industrial development and of encouraging the industries to finance more directly their industrial researches; and

15. Stations located at state universities will result in coördination of the ceramic work of the federal bureau and of the university experiment stations thus giving national scope and benefit to ceramic research financed to a large extent by the states and industries;

Therefore, be it resolved:

That the AMERICAN CERAMIC SOCIETY support Secretary Hoover whole heartedly in such of his plans for simplification and economy as do not involve curtailment nor abandonment of the general scope of the ceramic investigations now in progress in the Bureau of Standards and the Bureau of Mines.

To this end the following recommendations are urged for consideration. It is recommended:

First, that the work now being done by the Bureau of Standards on products and that by the Bureau of Mines on materials be continued apart and distinct as separate phases of the ceramic investigations;

Second, that the ceramic laboratories at Columbus and Pittsburgh and the plant and field contacts be continued and enlarged as the work in hand may require;

Third, that facilities be maintained so that the laboratory investigations on ceramic materials may be proved in the field and in industrial plants by Federal Bureau men, as is now being done by the Bureau of Mines; and

Fourth, that simplification and economies in the administration and direction of this work be carried as far as practicable without limiting the type of work now being done and that unification of control be provided so that unnecessary duplication of effort may be avoided, but not to the extent of materially changing the purposes or the character of the investigations now being carried on in both Bureaus.

Be it resolved further:

That copies of these resolutions be sent to Secretary Hoover and that they be published in the *Journal.*

In behalf of the Board of Trustees,

E. WARD TILLOTSON, *President.*

LOCAL SECTION NEWS

Baltimore-Washington Section, Dec. 5[1]

The second meeting for the 1925–26 season of The Baltimore-Washington Section of the American Ceramic Society will be held in Washington on Saturday, Dec. 5, 1925.

The meeting will open at 3:00 P.M., at room 237 Industrial Building, Bureau of Standards, where an inspection trip will be made of the industrial laboratories of the Bureau. Following the visit to the Bureau, the regular dinner will be served at 6 o'clock at the Lee House, 15th and M Streets, N. W., after which Dr. Brown, Assistant Director of the Bureau of Standards, will address the meeting.

Chicago Section, Dec. 10[2]

The officers of the Chicago Section announce that a meeting of the Section is being planned for Thursday evening, December 10, and is to be held in the rooms of the Chicago Engineers' Club, 314 South Federal Street, Chicago. It will begin with a dinner at 6:30 P.M., after which a very interesting program will be presented.

W. A. Darrah, who will be remembered as having presented a very interesting paper at Columbus on "The Vitreous Sanitary Ware Industry" will present a paper which will be of particular interest to enamelers inasmuch as it will deal with furnace installation for such. His paper will be illustrated by slides.

In addition to Mr. Darrah's presentation there will be others and, although this notice is addressed to members of the Society, we want anyone in any way connected with the ceramic industry to feel that this invitation is extended to them, also.

Meeting of the St. Louis Section, Nov. 6[3]

The meeting of the St. Louis Section was held at this time to take advantage of obtaining speakers from the National Brick Manufacturers Association who were assembled in St. Louis for their annual meeting. F. E. Bausch, Chairman, called the meeting to order.

A. V. Henry, Head of the Department of Ceramics, Georgia School of Technology, and B. M. Hood, of Atlanta, Georgia, were the chief speakers of the evening. Dr. Henry treated on the function of the technical ceramic schools and dealt in particular with the establishment of a Ceramic School in Missouri, what such a school would mean to the industry of the state and how it should be organized. Dr. Henry brought out the advantages of a school located at an institution such as Washington University which is an endowed one, as compared to a location at a State School, such as Rolla, which is dependent upon legislative appropriation. Further emphasis was placed upon the advisability of the ceramic school being located in the heart of the industry such as St. Louis is.

Following Dr. Henry's talk, round table discussion was held, a great many participating in this discussion. A number of graduates from Rolla were present and they dealt upon the advantages of a ceramic school in conjunction with an institution which teaches mining and metallurgy.

Prof. McCourt, Dean of the Engineering School, Washington University, was also present and spoke of the work of the University, and of their willingness to coöperate to

[1] D. H. Fuller, Secy.

[2] W. V. Knowles, *Chairman.*

[3] L. C. Hewitt, Secy.

the fullest extent in any movement that might result in the establishment of a ceramic course.

Mr. Hood gave a particularly interesting and instructive review of the possibilities of the ceramic industry in the South, also relating the means that were used in securing a Ceramic School for Georgia. Mr. Hood has a wide number of interests in the clay working industry in that State, and is the man who is responsible for bringing about the establishment of the Ceramic course at the Georgia School of Technology.

We were also fortunate in having with us at this meeting Jacob Stocke, Jr., President of the National Brick Manufacturers Association, J. W. Sibley, Treasurer, and Theo. A. Randall, Secretary. These gentlemen expressed their desire to coöperate in every way possible with the AMERICAN CERAMIC SOCIETY, bringing out the point that the men in all lines of the ceramic industry did have mutual problems.

H. A. Wheeler replied in behalf of the Local Section expressing the hope that the AMERICAN CERAMIC SOCIETY and the National Brick Manufacturers Association would again resume their policy of meeting at the same time in the same city at least every other year. Mr. Wheeler also related some points relative to the formation of the AMERICAN CERAMIC SOCIETY, bringing out the fact that the National Brick Manufacturers Association is, in reality, the parent organization.

At the close of our meeting a rising vote of thanks was given to Mr. Hood and Dr. Henry for their coöperation.

There were 34 present at the meeting, consisting of 15 visitors and 19 members, as follows:

VISITORS

H. C. Penfield, Bowery Savings Bk., N. Y. City
W. T. Bussell, Brazil, Ind.
A. P. Potts, Brazil, Ind.
A. V. Henry, Atlanta, Ga.
W. F. Demuth, New Philadelphia, Ohio
E. C. Enler, South Milwaukee, Wis.
J. R. Grout, Jr., Danville, Ill.
J. R. Green, Indianapolis, Ind.
F. M. Poole, Tulsa, Okla.
W. H. Merkel, Kansas City, Mo.
W. J. Becker, St. Louis, Mo.
B. M. Hood, Atlanta, Ga.
Mr. Kraus, Philadelphia, Pa.
M. W. Blair, Terra Haute, Ind.
Prof. McCourt, St. Louis, Mo.

MEMBERS (St. Louis Local Section)

C. B. Kentnor, Jr.
M. Epstein
J. B. Lyon
A. W. Buckingham
A. F. H. Seelig
H. A. Wheeler
W. D. Thompson
L. H. Blue
John W. Rogers
August Vollmer, Jr.
H. W. Weber
C. S. Haupt
W. H. Weber
Miss M. Regnier
F. E. Bausch
R. C. Gosreau
F. S. Markert
E. O. McFadden
L. C. Hewitt

PERSONAL NOTES

R. L. Frink who has recently been located in Dairen, Manchuria, with the South Manchurian Railway Co., has returned to Lancaster, Ohio.

J. R. Green has moved from Evanston, Ill., to 215 E. New York St., Indianapolis, Ind.

F. P. Hall, formerly at the Massachusetts Institute of Technology, has recently become associated with the Standard Oil Co. of New York City as Research Chemist.

J. B. Krak, Technical Editor of *The Glass Industry,* Jamaica, N. Y., has removed to 334 First St., Niagara Falls, N. Y.

James W. Moncrieff has moved from Stockton, Calif., to 1812 Pearl St., Alameda, Calif.

A. Nugent Ragland who has been associated with the Perth Amboy Tile Co., Perth Amboy, N. J., has moved to 2232 Sherman Ave., Evanston, Ill.

NOTES AND NEWS

ST. LOUIS ENAMELERS' CLUB

A meeting of the St. Louis District Enamelers' Club was held at Belleville, Ill., Nov. 24, 1925. Twenty-one members were present.

Adam Karr of the Karr Range Company of Belleville gave an interesting account of his recent trip through Europe where he spent three months. Mr. McFadden of the same Company read an excellent paper on spraying.

The officers of this Club are C. S. Haupt, President, E. A. Eigenbrot, Secy.-Treasurer and A. E. Krebs, Vice-president.

J. A. Holmes

THE BEGINNING OF CERAMIC INVESTIGATION BY FEDERAL GOVERNMENT

Credit for the first special division in a federal bureau belongs very largely to J. A. Holmes, the first director of the Bureau of Mines. He engineered the legislative bill and made provisions for carrying into effect the proposals contained in resolutions adopted and championed by the American Ceramic Society. We are pleased to have the privilege of acknowledging the obligations of ceramic people generally to Dr. Holmes.

DR. TURNER, NEW DIRECTOR OF BUREAU OF MINES

Scott Turner, of Lansing, Michigan, was recently appointed director of the federal Bureau of Mines to succeed H. Foster Bain, now Secretary of American Institute of Mining and Metallurgical Engineers. Dr. Turner is a mining engineer of international reputation. He received his A.B. degree from the University of Michigan in 1902 and his B.S. and E.M. from the Michigan College of Mines in 1904. For many years Dr. Turner held positions in milling and mining companies in the western states, as assayer, examining engineer and field work. For a short while he was assistant editor with T. A. Rickard of *Mining and Scientific Press* of San Francisco.

From 1905–06 Dr. Turner was superintendent of the San Pablo Gold Mining Co., and Pontiac-Panama Co., Province of Veraguas, Panama, and in 1908 he was associated with T. A. Rickard in Dawson, Fairbanks and Nome, Alaska. In 1911 he was directing field work in tin mines at Cornwall, England, and 1914 located in Spitsbergen in field work for J. M. Longyear of Boston. From 1911–16 he was agent for the Arctic Steamship Co., and during the two years succeeding he was in charge of field work in Peru, Bolivia and Chile. In 1919 he became construction engineer for the Mining Corporation in Canada (Toronto) and in 1921 he became associated with the U. S. Bureau of Mines as construction engineer.

For five years Dr. Turner opened and operated coal mines at 79° 13′ N. Lat. on the Island of Spitsbergen. This island is 825 miles north of the Arctic Circle on No Mans Land. Here he claimed and maintained possession of 600 square miles under the protection of the American flag.

He is the author of many articles for the technical press. During the War he served as military lieutenant, senior grade, U. S. N. R. F., April, 1918 to January, 1919. He is a survivor of the S. S. Lusitania which was sunk by a German submarine on May 5, 1915. Dr. Turner is a member of the American Institute of Mining and Metallurgical Engineers and the Canadian Institute of Mining and Metallurgy.

PROGRAM OF SECOND ANNUAL MEETING

Ohio Ceramic Industries Association

(November 20 and 21, 1925)

Friday Afternoon—November 20—1:00 P.M.

"The Ceramic School at East Liverpool," by Kenneth Smith.

"Ceramic Extension Service for Ohio," by Arthur S. Watts.

"The Organization of Agricultural Engineering Research through the Federal and State Agencies," by Professor G. W. McCuen, Ohio State Agricultural Engineering Department.

"The Coöperative Policies of the State Board for Vocational Education," by E. L. Heusch.

Saturday Morning—November 21—9:00 A.M.

"The Reorganization of Ceramic Research under the Federal Government and What It Means to the Ohio Industries," by R. C. Purdy.

"The Utilization of State Facilities by the Ceramic Industries," by A. V. Bleininger.

"The Necessity for Organized Plans by the Ceramic Industry before the State Can Provide Coöperative Aid," by Dean E. A. Hitchcock, College of Engineering, Ohio State University.

JAPANESE CERAMIC SOCIETY

By S. Kondo

The growth of the Japanese Ceramic Society was retarded not only by the War but by the earthquake in the Tokio district in 1923.

This Society, however, is showing a slow but steady progress in the quality of the contents of the Journals.

The officers have exerted themselves to the utmost for maintaining its status quo, also for its expansion in coming years. Open lecture-meetings were held every year in spring and autumn by its head-office in Tokio as well as its branches in Kioto, Osaka and Nagoya. The Standing Committee is now planning the third ceramic exhibition which will be held for three weeks in December in Tokio.

Kentaro Kaneko

The management of the Society is vested in the Standing Committees with three Directors, who are elected every year by the members of the Society. At present, O. Umeda is the Chief-director, K. Ishikawa,

the Vice-Chief-director and S. Kondo the Director of Editing. Chief-directors in recent years were: 1922, J. Kumazawa, 1923, S. Kondo and 1924, R. Shibata. Vice-Count K. Kaneko, former Minister of Agriculture and Commerce and now a Privy Councillor, has long been elected the President.

The membership figures follow:

	Honorary	Supporting	Ordinary	Total
March 31, 1922	5	14	1376	1395
March 31, 1923	5	18	1406	1429
March 31, 1924	5	18	1374	1397
March 31, 1925	4	18	1358	1380

NOTES FROM CERAMIC SCHOOLS

ALFRED UNIVERSITY

By C. F. Binns

The registration at Alfred this year reflects not only the large increase in enrollment experienced by nearly all colleges this fall but evidently a special interest in the subject of ceramics as demonstrated by the large number in the entering class. The registration figures follow:

	Men	Women	Total
Graduates	1	0	1
Seniors	7	9	16
Juniors	21	10	31
Sophomores	24	7	31
Freshmen	58	10	68
Specials	3	1	4
Totals	114	37	151

The ceramics school building, designed for 80 to 100 students, has been crowded to capacity the last few years notwithstanding the fact that the Department of Chemistry was forced to move to one of the college buildings so as to leave the space for laboratory work in ceramics. With 151 students now taking ceramic courses conditions are such that an immediate addition to the building is absolutely necessary.

Arthur H. Radasch

The New York State Legislature has been asked for three years to grant an appropriation of $60,000 for building and $15,000 for additional equipment. Their refusal means that a limitation must be placed on the enrollment. There has been no increase in the faculty although the number of students continues to grow greater every year.

Arthur H. Radasch Arthur H. Radasch, who has been appointed to succeed A. I. Andrews as Professor of Ceramic Engineering at Alfred University, graduated from the Massachusetts Institute of Technology with the degree of Bachelor of Science in Chemical Engineering. From 1920 to 1921 he was instructor of Industrial Chemistry and Chemical Engineering at Harvard College and North-

eastern College and was also connected with the Division of Industrial Coöperation and Research at M. I. T. In the summer of 1921 he was an instructor in Industrial Chemistry at Massachusetts Institute of Technology. In the fall of 1921 he came to Alfred as Professor of Chemistry in the New York State School of Clay Working and Ceramics. He has therefore had four years of association with this school before assuming his present duties.

Donald W. McArdle Graduate of M. I. T., 1918, S.B. in Chemistry. Graduate of Lowell Institute 1922 (Mech. Eng.). Two years graduate work M. I. T. (Chem. Eng.). After four years in chemical manufactories, spent three years at Boston University as instructor and assistant professor and is now located at Alfred.

GEORGIA SCHOOL OF TECHNOLOGY

By A. V. Henry

The Department of Ceramics, Georgia School of Technology, has entered its second year with two students in their junior year and ten in their sophomore year.

Since it was felt that any engineering department must have the coöperation of the industry to gain maximum success, a Coöperative Course in Ceramics is being given this year in addition to the regular four year course. Ten students are enrolled. In this course, a student alternates monthly in the school and a particular ceramic industry. Indications are that the Coöperative Course will be given enthusiastic support by the southern ceramic manufacturers.

During the past year the Department entered into a coöperative agreement with the Central of Georgia Railway to further study the sedimentary kaolins of Georgia. Two major subjects are being investigated, the first of which is "The Refining and Blending of the Sedimentary Kaolins of Georgia" and the second, "The Use of Georgia Clays in Saggers." The investigation is expected to continue for at least one year. W. H. Vaughan who received his degree of Master of Science in the Ceramics Department, University of Illinois last year is now engaged in this work.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

By S. W. Stratton

It has been announced that a course in Ceramic Engineering will be introduced at the Massachusetts Institute of Technology at the beginning of the next academic year. The personnel is being selected and provisions are being made for housing and general equipment.

IOWA STATE COLLEGE

By Paul E. Cox

The Department of Ceramic Engineering at Iowa State College has 30 men enrolled for the four year course and additionally handles the ceramic engineering work for 50 young women who work in modeled pottery in the department under the direction of Miss Mary L. Yancey. These young women are enrolled in other departments of the College.

At Ames nearly all ceramic engineers are converts from other departments, so that we have one freshman and one graduate student, with 28 others in between, 7 of them being seniors. Most preps have never heard of ceramics and so come for radio. The

freshman year is planned to be elastic enough to allow a change of course without loss to the student.

There are no new facilities of any importance for teaching work though a group of senior students are working on special problems and two or three small bits of equipment have been built from their ideas. These jobs are interesting because they are initiative developers.

All Ames graduates from the department write of enjoyment in ceramic work, and one man came in and spent the time here rubbing it in on his brother who is engaged in teaching electrical engineering. The ceramic man is working in enameled metal and twits his brother by telling him that in ten years the ceramic graduate can expect to be ready to start his own plant while the electrical engineer may expect to still have a salaried job with a corporation in the same time. Lately the department placed a man from another department since no ceramic men were available.

NORTH CAROLINA STATE COLLEGE

By A. F. Greaves-Walker

I. General 1. Students registered for 1925–26: 10 freshmen, 9 sophomores, 1 junior.

2. The appointment of George R. Shelton as assistant Professor of Ceramic Engineering has already been announced in the *Bulletin*.

The new ceramics building will probably not be completed until the latter part of the winter term, although the classrooms, office and chemical laboratory will be ready for occupancy in about 30 days. Much of the equipment is on hand or arriving. At least half of this equipment, while useful for the students' laboratory work, is to be devoted primarily to research and experimental work in connection with the development of the ceramic industries in North Carolina and in the South.

3. The Department is carrying on a coöperative research project with the North Carolina Department of Conservation and Development to determine the commercial value of the shales of North Carolina. The Department of Conservation and Development is carrying on the geological end of the project.

4. The research projects in progress are:

(*a*) A study of the structural clay products plants of North Carolina to determine the improvements that can be made in product and equipment. This project has been under way for a year and is almost completed.

(*b*) A study of North Carolina to determine its shale resources and the determination of the commercial uses to which the shales can be put.

(*c*) The investigation of the pyrophyllite deposits of North Carolina to determine their value for refractories manufacture.

5. A student branch of the AMERICAN CERAMIC SOCIETY is holding monthly meetings in which a great deal of interest is being taken.

II. Short Course in Clayworking and Ceramics

The department of Ceramic Engineering at North Carolina State College, Raleigh, N. C., announces the second annual Short Course in Clayworking and Ceramics, which will be given at the College, January 18th to 27th, 1926, inclusive.

The course has been increased in scope and will this year cover nine days instead of six as was the case last year. Lectures will be given in the following subjects, by members of the faculty of the departments of Ceramic Engineering, Mechanical Engineering, Electrical Engineering, Architectural Engineering and Business Administration.

1. Chemistry of Clays
2. Origin and Properties of Clays
3. Prospecting and Sampling
4. Mining of Clays
5. Dies and Auger Machines
6. Driers and Drying
7. Kilns and Firing
8. Fuel and Fuel Economy
9. Steam and Steam Power
10. Boiler Feed Water
11. Electric Motors and Their Uses
12. Care and Maintenance of Machinery
13. Business Principles
14. The Use of Brick in Buildings.

The course deals with the principles underlying the work of managers, superintendents, foremen, burners and others engaged in the brick, hollow tile and sewer pipe industries. A common school education will suffice as preparation for the course.

Last year thirty students representing nineteen states enrolled in the course. A larger enrollment is expected this year. The new Ceramics Building at the College will in all probability be completed before the course opens.

The course will be open to all those interested, whether residents of North Carolina or not. No fee will be charged. A bulletin covering the course will be issued in December and will be sent on request.

III. Correspondence Course for Enamelists

A. F. Greaves-Walker of the North Carolina State College, Raleigh, N. C., announces that a new correspondence course in Ceramic Engineering designated as Cer. E. 210A, "Enamels and Enameling," is now ready. This course covers the subject of enameling on iron and steel in a very thorough manner and is designed especially to give technical training to the non-technical enamelist in simplified terms and formulas.

The course begins with an assignment of the chemical terms and the chemistry of the industry, which is followed by assignments on raw materials; calculation of melted weights and percentage composition; classification of enamels for cast iron; classification of enamels for sheet steel; coefficients of expansion of enamels; chipping, crazing, fish scaling; method of calculating coefficients of expansion; relation between chemical composition and physical properties; mixing, melting, drying and grinding apparatus; preparation of iron and steel and types of furnaces.

The course will be under the supervision of George Reed Shelton of the Ceramic Engineering faculty. The registration fee is $7.50. Three college credits are granted upon satisfactory completion of the course.

Bulletin and registration blanks may be obtained by addressing Frank Capps, Director of College Extension, North Carolina State College, Raleigh, N. C.

OHIO STATE UNIVERSITY

By A. S. Watts

Registration 1925–26, according to College of Engineering records, 19 seniors, 27 juniors, 45 sophomores, 37 freshmen (up to October 15).

Note: Freshmen do not choose any department except by voluntary announcement, until the end of the first year.

New Teaching Facilities

Samuel R. Scholes becomes a member of the faculty and will teach a special course in fine ceramics, dealing especially with glass, as a portion of the senior laboratory assignment.

The department has obtained new equipment consisting of a Palo Furnace, new ball mill room equipment for twelve men and new locker equipment for 20 men. The new humidity control drier installed by Proctor and Schwartz Company will make it possible to conduct investigations in problems of drying not heretofore possible.

F. C. Westendick

Three post graduate researches are in progress having the following subjects:

1. "Further Study of the Heat of Summation of Ceramic Bodies." (Coöperation with Bureau of Mines.)
2. "Eutectic Study of the Alkali and Lead Barrow Silicates and Alumina."
3. "The Influence of Composition on the Specific Gravity of Some Industrial Glasses."

Frank Westendick

Mr. Westendick, instructor in the Department of Ceramics, was born at Louisville, Ky., 1891. He followed the electrical profession until 1911 from which time until 1923 he was associated with social service work. He entered at Ohio State University in 1920 and was graduated from Ceramic Engineering College in 1925, where he was student assistant during 1924–25. He worked for the National Fire Proofing Co. on drier trouble during the summer of 1924 and worked for the Windsor Brick Co. on gas firing problems during summer of 1925.

PENNSYLVANIA STATE COLLEGE

By J. B. Shaw

This department has started the year 1925–26 with a total registration of 18, subdivided as follows: seniors 1, juniors 6, sophomores 7 and freshmen 4. One instructor was added to the department, Walter A. Preische, graduate of Alfred University to be employed in this capacity. The equipment has been materially increased by construction of furnaces and purchase of considerable apparatus required in the department. The equipment at present is considered entirely adequate although, of course, if funds were available much more elaborate equipment might be installed.

The department has been under some slight disadvantage owing to the fact that natural gas is not available for laboratory use but after some considerable experimenting it was found that this disadvantage has been entirely overcome and results are now being obtained with oil fuel as satisfactorily as can be obtained with natural gas. It has been

found that the difficulty incurred in using oil fuel results from the failure to filter properly the fuel, or the use of a low grade of fuel. The department at present is using kerosene oil which would be too expensive for commercial purposes but the difference in cost is negligible for the amount used in the laboratory and if furnaces are properly constructed and the equipment rightly controlled there is no difficulty in obtaining most any kind of furnace condition as regards oxidation or reduction of temperature that is desired.

The Pennsylvania State Geology department and George H. Ashley have outlined a program to make a complete survey of the clays of the state. This work has been placed under the direct supervision of J. B. Shaw, Head of the Department of Ceramics at Penn State. Samples are now being collected which will subsequently be tested in the laboratory of the department. The work has been started on fire clay with particular attention being paid to flint fire clay. It is expected that this portion of the work will be completed within a year.

The department of ceramics is meeting with enthusiastic support on the part of the manufacturers of the state which augurs well for its success. Numerous trips are taken by the students to manufacturing establishments where the students are given an opportunity to tie in the practical side of ceramics with the technical work which they receive in the department.

The department at Penn State is taking full cognizance of the discussion now being carried on as a result of the efforts of the Committee of Education of the AMERICAN CERAMIC SOCIETY and while no new courses are being added at present the work in the courses as listed is being somewhat modified with a view to laying more stress on Ceramic products than heretofore. It is felt, however, that the present curriculum at Penn State already recognizes the importance of the subject under discussion and in fact much of the work deals with properties, uses and testing of ceramic products.

RUTGERS UNIVERSITY

BY GEORGE H. BROWN

There are twenty-seven students enrolled in the Ceramics course at the present time. Walter L. Shearer, who has been associated with the department since 1923 in the capacity of instructor and research assistant, has been appointed Assistant Professor of Ceramics. Geo. C. Betz, formerly with the New Jersey Terra Cotta Company, has been added to the staff in the capacity of Instructor and Research Assistant, while Wilbur R. Wyckoff, a graduate of the class of 1925, is serving as a research assistant.

The department is coöperating with the various ceramic plants in the State in the solution of their manufacturing problems. A new apparatus has been assembled and is being used in the measurement of the coefficients of expansion of refractory and other ceramic materials. Research work is being done with a view to ascertaining the value of p_H determinations in the control of casting slips. A series of experiments in the use of Cornwall stone in vitreous bodies is now under way.

The Rutgers Ceramics Club and Student Branch of the AMERICAN CERAMIC SOCIETY is holding regular monthly meetings. At the meeting on October 8, 1925, the following officers were elected for the 1925–26 season. President, Leonard Hepner; Vice-President, D. Koch; Treasurer, G. Danskin; Secretary, John R. Kauffman. Leslie Brown of Lenox, Inc., Trenton, N. J., will address the Club on November 19th on the "Manufacture of Lenox Ware." His talk will be illustrated by a moving picture showing the processes of manufacture in detail. The Club has arranged to have talks by prominent ceramic men at each meeting.

Recent graduates of the Ceramics Department at Rutgers University are employed in the following plants:

Fraser B. Rhodes, Robertson Art Tile Co., Trenton, N. J.

Geo. T. Morse, Enterprise White Clay Co., Philadelphia, Pa.

N. Johnson Kent, The Johns-Manville Co., Manville, N. J.

S. Habas, Instructor, Dept. of Chemistry, Rutgers University, New Brunswick, N. J.

M. B. Catlin, investigative work in German ceramic plants.

J. A. Plusch, inspector on tile for new Holland Vehicular Tunnel, Plant of American Encaustic Tiling Co., Zanesville, Ohio.

Clinton R. Kennaday, Woodbridge Ceramic Corp., Woodbridge, N. J.

L. R. Squier, New Jersey Terra Cotta Co., Perth Amboy, N. J.

H. T. Cunningham, The Carborundum Co., Perth Amboy, N. J.

Rodney T. Rouse, Golding Sons Co., Trenton, N. J.

C. Edwin Prentice, Sayre & Fisher Co., Sayreville, N. J.

UNIVERSITY OF ILLINOIS

By C. W. Parmelee

The eighty-eight who are registered in ceramics at the University of Illinois, 1925–26 may be classified as follows:

Seniors	12
Juniors	21
Sophomores	27
Freshmen	25
Graduate	3
Total	88

New teaching and experimental facilities secured this year are (1) three furnaces given to the department by the Illinois Gas Manufacturers Association, (2) Carrier Ejector Processing Cabinet and (3) Grinnell Drier.

Coöperative research is being conducted on (1) electrical porcelain and (2) power plant refractories and gas machine refractories. This research is carried on with certain utilities companies of North Illinois and this department.

Other research problems in progress at this time are (1) An investigation of firing conduct of certain Illinois shales, (2) An investigation of hard finish plaster, (3) An investigation of drying of clay ware.

Our graduates of June, 1925 are located with the following firms:

Abney, Charles L., Columbus Brick and Tile Co., Columbus, Ga.

Bopp, Harold F., 305 Main St., Dundee, Ill.

Bradley, Richard S., A. P. Green Fire Brick Co., Mexico, Mo.

Fels, Clarence G., Atlanta Terra Cotta Co., Perth Amboy, N. J.

Foster, Edwin S., 1090 Peralta Ave., Berkeley, Calif., N. Clarks and Sons.

Grigsby, Chester E., Department of Ceramic Engineering, University of Illinois, Urbana, Ill., Refractories Research.

Grout, Jack R., Jr., Acme Brick Co., Danville, Ill.

Halloin, William G.

Innes, David H., Zwerman Company, Robinson, Ill.

Lampe, Chester E.

McNair, Francis G., 75 N. Batavia Ave., Batavia, Ill.

Parmelee, C. Everett, Pittsburgh Plate Glass Co., Crystal City, Mo.

Schroeder, George C.

Vaughan, W. Harry, M. S. in Ceramic Engineering, Georgia School of Technology, Atlanta, Ga.

Whitney, W. Percy., Lancaster Brick Co., Lancaster, Pa.

Short Course in Ceramics to be Given in January

The University of Illinois announces a Short Course in Clay Working and Enameling to be given January 11 to 23, 1926.

The course is designed to meet the requirements of practical men. It will deal with the principles underlying the work of managers, superintendents, foremen, burners and others who may be concerned with the manufacture of ceramic products.

A common school education will suffice as preparation for the course. No fees are required, but a contribution of one dollar toward the expense of printing leaflets necessary in certain courses is to be made by each person upon registration.

The course of instruction will include lectures, laboratory work and informal discussions. Besides the members of the staff of the Dept. of Ceramic Engineering and members of the Engineering and other faculties of the University of Illinois, it is expected that M. C. Booze of Mellon Institute, Pittsburgh, Pa., R. R. Danielson of the A J. Lindemann and Hoverson Co., Milwaukee, Wis., and A. S. Watts, Head of the Dept. of Ceramic Engineering of Ohio State University, will assist.

Programs may be had upon application to the Department of Ceramic Engineering, University of Illinois.

UNIVERSITY OF SASKATCHEWAN

By W. G. Worcester

We have four students in the third year, none in the fourth year and as to how many in the first and second years we have no means of knowing, owing to the fact that they do not register as ceramic students until the beginning of their third year.

As to new teaching and experimental facilities, I am pleased to say that our new quarters are rapidly nearing completion. We expect to be in them by the first of the year and will have at our command twice the space we formerly had as well as much new equipment that we could not place in the old quarters owing to lack of space.

We are not conducting any research work largely in that the time of the department and myself is being taken up with the solving of industrial problems and in the assisting of new development as well as conducting a survey of the Saskatchewan ceramic materials.

As to our graduates, I am pleased to state that our first men turned out are holding positions, one with the Evens and Howard Refractories Plant at St. Louis and the other with the Ontario Sewer Pipe Company at Toronto. Both men I am told are doing very well.

UNIVERSITY OF TORONTO

By R. J. Montgomery

The ceramic work here is open to 4th year students as an option in the School of Applied Science. The students taking the work this year give about three-quarters of their time to it, including their thesis. We are hoping next year to extend the work to go beyond the one year, as it is rather difficult to cover general lectures and advanced labo-

ratory work the same year. Three students are registered this year. Two of them are 4th year chemical engineers, specializing in ceramics. The third man is in the graduate school, having graduated last year in geology and specializing this year in nonmetallic minerals.

In regard to equipment, we are gradually getting together the usual laboratory outfit; nothing special so far has been obtained.

In regard to coöperative research and other departmental work, we are hardly far enough along yet to be doing anything along that line. The local clay manufacturers are submitting samples for our study, and that is about as far as we have gone as yet.

These notes are rather meager, but a new department cannot furnish very much. I hope that next year we will have more activities to report upon.

UNIVERSITY OF WEST VIRGINIA

W. A. Koehler

W. A. Koehler W. A. Koehler was appointed head of the Ceramics Division of the Chemical Engineering Department at the University of West Virginia, Morgantown, W. Va., in 1924. Dr. Koehler received his B.S. degree in Chemical Engineering at the University of Wisconsin in 1919 and the following year was assistant in that department. During 1920–21 he was research chemist with the Carborundum Company and 1922 took his master's degree in ceramic chemistry at the University of Illinois where he was a scholar. He received a scholarship at the University of Wisconsin where he studied colloid chemistry under Svedberg and took his Ph.D. in physical chemistry in 1924. Dr. Koehler states that West Virginia offers a large field for technically trained men in ceramic lines. "The state contains 80 glass plants employing 14,760 people; 21 potteries employing 4600 people; with 1300 distributed among enameling plants, brickyards and structural tile plants."

UNIVERSITY OF WASHINGTON

By Hewitt Wilson

The department of ceramic engineering at the University of Washington, Seattle has 6 major students in ceramics and 4 minors. The minors are those who will get their degree in other departments but are taking practically all the ceramic courses. Of this group of 10, 5 are graduate students, 4 are seniors and one is a junior.

We have our usual coöperative research work in progress with the Northwest Experiment Station of the U. S. Bureau of Mines. The subject of investigation this year is a study of the whiteware materials of the Pacific Northwest, including the kaolins of Eastern Washington and the feldspars from various sources. Roland Clark, one of the Bureau of Mines fellowship men and a graduate of the New York School of Ceramics, is designing and operating a new type of clay washing apparatus for the purification of these white firing clays.

Hewitt C. Fearn, graduate student from Columbia University and holder of a Bureau of Mines fellowship, is designing a humidity drier for research work with the clays of southwest Washington which have been giving trouble in drying.

Henry N. Baumann, graduate student from the University of Washington and holder of the third Bureau of Mines fellowship is working with Thomas E. Nicholson, senior, in testing the efficiency and obtaining a heat balance for wood fired periodic kilns, coal fired Hoffman continuous kilns, terra cotta muffle kilns and sewer pipe kilns.

Hobart R. Goodrich, senior, is developing a spalling test for fire clay brick using the loss in strength after thermal shock as the indicator. Thad O. Smith, senior, is testing local sands and quartz rocks for possible glass sands.

Other research work which is being carried on in the department includes the development of a test for plaster of Paris (pottery molding plaster), and some experiments in coöperation with the Pacific Northwest Section of the Common Brick Manufacturers Association to eliminate the scumming effect of the gypsum in Portland cement mortars for brickwork.

CERAMIC NIGHT SCHOOL AT EAST LIVERPOOL

Registration for the East Liverpool Ceramic Night School opened on Monday evening, November 26. Kenneth M. Smith, Director, is to be in charge of this work and talks were made by A. V. Bleininger of the Homer-Laughlin China Co., Newell, W. Va., and E. L. Heusch, State Superintendent of vocational training.

An outline of the course includes practical studies such as mechanical drawing, shop arithmetic, physics, chemistry and ceramics.

The subjects are presented in a simplified form so as to make them readily under standable to the potter or student who may not have had any previous training in these branches. Progress will be made slowly so as to give each registered student opportunity to lay satisfactory foundations in his work. The members of the teaching corps from Director Smith down, wish to have it emphasized that they will be there to help and not to embarrass anybody; and therefore they respectfully request any workman in the shop who is ambitious to increase his knowledge respecting the theoretical or practical sides of the ceramic industry to register. The first course will run for twelve weeks.

DR. BINNS LECTURES AT METROPOLITAN

Charles Fergus Binns, Director of Ceramics at Alfred University is engaged in a series of lectures on pottery at the Metropolitan Museum of Art. Four of these were presented in November on (1) Nature and properties of clay, (2) The shaping of clay ware from fluid, plastic and semi-dry material, (3) Kilns and firing, (4) Glazes and glazing.

The remaining two lectures will be given on December 4 and 11, respectively, the first on "Technical Types as Illustrated by Museum Specimens—Low Temperature Ware, Earthenware Faience." The final lecture will be "Technical Types as Illustrated by Museum Specimens—High Temperatures—Stoneware and Porcelain."

This series is presented under the auspices of the Arthur Gillender lectures.

W. E. S. TURNER HONORED BY THE GLASS INDUSTRY[1]

An honor which will give pleasure to University colleagues and other friends in Sheffield, and to glassworkers throughout the country, has been conferred on Professor

[1] From the Sheffield Daily Telegraph, Oct. 19, 1925.

W. E. S. Turner of the University of Sheffield. In recognition of his services to the glass industry, Professor Turner has been made on honorary freeman of the Worshipful Company of Glass Sellers of the City of London.

Professor Turner is the head of the Department of Glass Technology at Sheffield University. He was appointed to that position when the department was founded in 1915, and has thrown himself with great energy and success into the development of the work, which has been of much value to the glass industry. He also took the leading part in the establishment of the Society of Glass Technology, of which he was at first secretary and has since been president.

Last May the Court of the Company of Glass Sellers paid a visit to the Department of Glass Technology and the link which binds them to Sheffield will be strengthened by the admission of Dr. Turner to their freedom. The honor was conferred upon him at a meeting of the Court. Subsequently, he and Mrs. Turner were among the guests at the dinner to the Lord Mayor and Sheriffs in the Carpenters' hall, and the Prime Warden of the Company in his speech made a reference to the work which Professor Turner was doing at the Department of Glass Technology.

SOCIETY OF GLASS TECHNOLOGY

The first meeting of the Society of Glass Technology for the Session 1925–26, was held in Sheffield on October 21, when the President, T. C. Moorshead, delivered his Presidential Address on "The Glass Bottle Industry and Its Future Developments."

At the outset Mr. Moorshead pointed out that the comparative lack of definite knowledge of the structure and characteristics of glass and the means of controlling its manipulation with absolute certainty had to a large extent retarded the development of the mechanical phases of the industry. Yet the last quarter of a century had seen practically a complete revolution in the manufacture of glass containers, and this period formed one of the most important epochs in the history of the glass bottle industry, economically, scientifically and commercially.

About 1900 two ideas, totally different in principle, suddenly blossomed forth. One was Homer Brooke's idea of feeding a machine with a stream of glass flowing by gravity from the furnace, the other was the application of the suction principle in feeding the machine, a process developed by M. J. Owens. From this time progress in the development of mechanical devices for glass manufacture had been rapid. With the development of automatic processes there had come a very great improvement in the character of all of the auxiliary plant and equipment, with the result that today many bottle manufacturing plants were practically mechanically operated throughout.

Future developments in the gravity process and in the suction process depended on different factors. The success of the suction process lay in its application to mass production, but it was not economically adaptable to the smaller units. With the gravity flow process it should be possible, on account of the comparatively simple auxiliary plant required for feeding, to produce articles more economically and at the same time to obtain the desired flexibility of operation.

After dealing briefly with leers, including "heatless" leers, Mr. Moorshead went on to discuss furnace design, a subject which had been very much neglected. Properly coördinated research work, exploring the problem thoroughly, would no doubt be rewarded with valuable information. In the firm belief in the feasibility of the principle of feeding and melting the batch at the same time and with a view to blazing the trail for future and more extensive research work, the United Glass Bottle Manufacturers, Ltd., were arranging to finance some experimental work based on the principles outlined

by Alex. Ferguson and described to the Society of Glass Technology in May, 1923. Details of the proposed experiments were given; the theoretical advantages claimed for the new process being (1) Smaller radiating surface per ton of furnace melting capacity, the ratio being approximately 2:1. (2) More intimate contact between the flame and the constituents of the batch. The first mentioned, however, depended upon (*a*) the feasibility of melting the batch, when pulverized and fed into the furnace in fine powder in the short time of passage through the flame; (*b*) the corrosive effects of the stream of melted glass on the side walls of the funnel shaped melting chamber, as well as the effect on the glass itself. In conclusion, the mechanical development of the bottle industry in the past 20 years had been little short of marvellous, and in mechanical efficiency was probably not surpassed by any other manufacturing industry. Nevertheless, still further research was necessary to discover a formula from characteristics other than that with which they had to deal today. Further knowledge of the mechanical properties of glass would also assist in opening up new fields or markets which had heretofore been untouched, and considered outside of the domain of the glass manufacturer. A discussion followed.

PUBLICATION OF INTERNATIONAL CRITICAL TABLES

Numerical Data of Physics, Chemistry and Technology

Announced by the National Academy of Sciences and the National Research Council of the United States

In making the publication contract, the National Research Council has reserved to members of scientific and engineering societies, and to libraries and research laboratories, for a certain period, the right to purchase the volumes at the estimated manufacturing cost.

The work of compiling International Critical Tables was undertaken by the National Research Council at the request of the International Union of Pure and Applied Chemistry, with the endorsement of the International Union of Pure and Applied Physics, and under the auspices of the International Research Council.

The material contained in International Critical Tables has been collected and critically evaluated by some 300 Coöperating Experts, including chemists, physicists, and engineers of the United States, Canada, Great Britain, Belgium, France, Italy, Austria, Germany, Denmark, Switzerland, Holland, Australia and Japan.

The editorial expenses (about $170,000) have been contributed by American industrial firms and Benevolent Foundations. The work of the Coöperating Experts, which is practically gratuitous, may be assigned a money equivalent of not less than $300,000. The cost of printing and distribution will be about $100,000 and the whole undertaking represents a money value of at least $570,000, of which the returns from subscriptions will represent only a minor part.

The scope of the material collected covers all available information of value concerning the physical properties and numerical characteristics of (*a*) pure substances, (*b*) mixtures of definite composition, (*c*) the important classes of industrial materials, (*d*) many natural materials and products, and (*e*) selected data for selected bodies or systems, such as the earth and its main physical subdivisions and the solar and stellar systems. Publications of the world in all languages have been combed for data and much unpublished information has also been collected.

In addition to their wide scope, the tables will contain many novel features of arrangement. Thus, for example, not only will it be possible to find readily all of the properties of a given substance or material, but it will also be possible in many cases to

ascertain readily what substance or material of a given kind has a maximum, a minimum, or a given value for any given property. This feature will be of great assistance in identifying a substance by means of its properties or in selecting a substance or material on the basis of a given property or combination of properties.

The principal language employed will be English; but much of the explanatory text, the tables of contents, and the very complete index, will be given also in French, German and Italian.

The work will be issued in five volumes, comprising an estimated 2500 pages ($8^1/_2$ by 11 inches), and the Editors are making every effort to compress the material which has been collected into the available 2500 pages. All volumes will be bound in a uniform reinforced buckram binding, and will be delivered to all advance subscribers as issued, with packing and carriage charges prepaid.

In making the publication contract, the National Research Council reserved for scientific men the right to purchase International Critical Tables at a price which represents substantially only the cost of printing and distributing, on the following basis:

1. International Critical Tables will be published at the price of $60 for the five-volume set, at which price all orders placed directly with the publishers will be filled.

2. Until the appearance of Volume One (early in 1926) but not thereafter, the following classes of persons and institutions shall have the right to subscribe at the rate of $35 for the set of five volumes.

(*a*) Individuals who are members of a recognized scientific or technical society; but only one set may be subscribed for by one individual.

(*b*) Educational institutions, public libraries, government departments, research laboratories, and the libraries of industries. Such organizations may purchase a number of sets if required for their own use.

3. No order can be accepted from or through book dealers or agents at the pre-publication price.

CALENDAR OF CONVENTIONS

Organization	Date	Place
Amer. Assn. for Advancement of Science	Dec. 28–Jan. 2	Kansas City, Mo.
AMERICAN CERAMIC SOCIETY	Feb. 8–13, 1926	Atlanta, Ga.
American Chemical Society (Spring Meeting)	April 5–9, 1926	Tulsa, Okla.
American Concrete Institute	Feb. 23–26, 1926	Chicago, Ill.
Amer. Electrochemical Society	April 22–24, 1926	Chicago, Ill.
American Engineering Council	January, 1926	
American Face Brick Association	Dec. 1–3, 1925	Atlanta, Ga.
American Foundrymen's Assn.	Sept. 27, 1926	Detroit, Mich.
Amer. Institute of Chem. Engrs.	Dec. 2–5, 1925	Cincinnati, Ohio
Amer. Institute of Min. and Met. Engrs.	February 15, 1926	New York City
American Mining Congress (Annual Meeting)	Dec. 9–11, 1925	Washington, D. C.
Amer. Soc. Steel Treating	Jan. 21–22, 1926	Buffalo, N. Y.
Amer. Soc. Testing Materials	June 21–26, 1926	Atlantic City, N. J.
Amer. Zinc Institute	April 27–28, 1926	St. Louis, Mo.
Assn. Chemical Equipment Mfrs.	May 10–15, 1926	Cleveland, Ohio
Assn. Iron and Steel Mfrs.	May 31–June 5, 1926	Chicago, Ill.
Associated Tile Manufacturers	December 9, 1925	New York City

Organization	Date	Place
Baltimore-Washington Section (American Ceramic Society)	Dec. 5, 1925	Washington, D. C.
Canadian National Clay Products Association	Jan. 26–28, 1926	Toronto, Canada
Coal Mining Institute of America	Dec. 9–11, 1925	Pittsburgh,
Common Brick Manufacturers	February 22–26, 1926	New Orleans, La.
Grinding Wheel Mfrs. of U. S. and Canada	Dec. 11, 1925	Buffalo, N. Y.
Hollow Building Tile Assn.	January, 1926	Chicago, Ill.
Manufacturing Chemists' Association	May or June, 1926	Near New York City
Natl. Acad. of Sciences (Spring Meeting)	April 26–28, 1926	Washington, D. C.
Natl. Assn. of Mfrs. of Pressed and Blown Glassware	March 9, 1926	Pittsburgh, Pa.
Natl. Assn. Stove Mfrs.	May 12–13, 1926	New York City
Natl. Exposition of Power and Mechanical Engrs.	Nov. 30–Dec. 5, 1925	New York City
Natl. Exposition of Coal Mining Mach.	Dec. 2–5, 1925	Cincinnati, Ohio
Natl. Paving Brick Mfrs. Assn.	January, 1926	
Natl. Society Vocational Education	Dec. 3–5, 1925	Cleveland, Ohio
Natural Gas Assn. of America	May 17–20, 1926	Tulsa, Okla.
New Jersey Clayworkers' Assn.	Dec. 18, 1925	New Brunswick, N. J.
Sand-Lime Brick Assn.	Feb. 9–15, 1926	New Orleans, La.
Taylor Society	Dec. 3–5, 1925	New York City

Official Personnel of Divisions—1925-26

	Art	Enamel	Glass	Heavy Clay Products	Refractories	Terra Cotta	White Ware
Chairman	Mary G. Sheerer	M. E. Manson	A. Silverman	John D. Martin	C. E. Bales	E. C. Hill	F. H. Riddle
Vice-Chairman	Margaret K. Cable		Herbert Insley		R. F. Geller	W. J. Stephani	
Secretary	H. Clinton Baldwin	H. G. Wolfram	A. N. Finn	Amos P. Potts	L. C. Hewitt	G. M. Tucker	F. H. Rhead
Committee on Research	F. H. Rhead	H. F. Staley	E. W. Washburn	F. G. Jackson	R. F. Ferguson	H. G. Schurecht	A. V. Bleininger
Committee on Standards (*a*) Tests (*b*) Products	(*a*) C. F. Binns (*b*) F. H. Rhead	(*a*) E. P. Poste	(*a*) R. F. Brenner (*b*) A. E. Williams	(*a*) A. V. Henry (*b*) Hewitt Wilson	G. A. Bole	(*a*) C. W. Hill (*b*) W. L. Howat	(*a*) Geo. Sladek (*b*) Robert Twells, Jr.
Committee on Data	H. S. Kirk	T. D. Hartshorn	J. W. Cruikshank	R. E. Arnold	D. W. Ross	T. A. Klinefelter	E. Schramm
Comm. on Membership	W. W. Wilkins	R. A. Weaver	J. M. Hammer	R. A. Horning	C. F. Geiger	Geo. P. Fackt	Ira E. Sproat, *Chairman* Geo. Simcoe A. A. Wells
Committee on Rules	Arthur Baggs	R. R. Danielson	S. R. Scholes	W. D. Richardson	W. E. Dornbach	W. A. Hull	E. H. Fritz
Committee on Education	Edna P. Carson	R. D. Landrum	Henry W. Hess	H. R. Straight		A. F. Hottinger	
Rep. Comm. on Nominations	H. S. Kirk	R. R. Danielson	A. W. Kimes	Marion W. Blair	F. W. Donahoe	F. B. Ortman	Perry Forst
Councillors	Frederick Carder Paul Cox Jane Hoagland		F. C. Flint A. E. Williams G. E. Barton	O. J. Whittemore		W. H. Powell H. J. Lucas Atholl McBean	
Committee on Papers and Program	Myrtle M. French	J. E. Hansen	J. C. Hostetter H. Insley F. C. Flint	F. T. Owens	Louis J. Trostel	Oscar Mathiasen D. F. Albery H. E. Davis	C. C. Treischel F. H. Rhead T. A. Shegog
Comm. on Coöperation			James Gillinder	J. L. Child	L. C. Hewitt	P. G. Larkin	R. F. Geller Perry Helser Stephen Leech
Committee on Contact			W. M. Clark	G. A. Bole		R. N. Long	
Editor: Question Box	Margaret K. Cable		R. R. Shively		E. E. Ayars	Hewitt Wilson	
Committee on Exhibitions	Martha G. Westfeldt	W. V. Knowles	A. R. Payne	B. Mifflin Hood		B. S. Radcliffe	
Trustee	Paul E. Cox	R. R. Danielson	J. C. Hostetter	C. Forrest Tefft	J. S. McDowell	R. L. Clare	C. C. Treischel

AUTHOR INDEX TO BULLETIN

The reference number in parentheses refers to the *monthly* number of the *Bulletin;* the number following this is the page number. The letters A, O, D, or E preceding reference number indicate that the articles are Abstract (A), Original (O), Discussion (D), or Editorial (E).

VOLUME 4

SUBJECT INDEX TO BULLETIN

Not front covers came down

BUYERS' GUIDE

A

Air Compressors
General Electric Co.

Alumina (Hydrate and Calcined)
Harshaw, Fuller & Goodwin Co.
Pennsylvania Salt Mfg. Co.

Alundum (Refractory Products)
Norton Co.

Auger Machines
Chambers Brothers Co.

Automatic Brick Machinery
Lancaster Iron Works, Inc.

Automatic Cutters
Chambers Brothers Co.

Automatic Stove Rooms
Philadelphia Drying Machinery Co.

Automatic Temperature Control
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

B

Ball Mills
Hardinge Co.
McDanel Refrac. Porcelain Co.
Mueller Machine Co., Inc.

Batts (Alundum-Crystolon)
Norton Co.

Bitstone
Potters Supply Co.

Bituminous Coal
Seaboard Fuel Corp.

Blocks (Refractory)
Norton Co.
Parker Russell Co.

Boats, Combustion
Norton Co.

Borax
American Trona Corp.
Innis, Speiden & Co.

Boric Acid (Crystal, Granular or Powder)
American Trona Corp.
Innis, Speiden & Co.

Brick Making Machinery
Chambers Brothers Co.

Bricks (Refractory-Alundum-Crystolon)
Norton Co.

Burners (Oil)
Best, W. N. Corp.

C

Cars (Clay)
Lancaster Iron Works, Inc.

Carbonates (Barium-Lead)
Innis, Speiden & Co.

Caustic Soda
Pennsylvania Salt Mfg. Co.

Cements
Norton Co.
Parker Russell Co.

Ceramic Chemicals
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Metal & Thermit Corp.
Paper Makers Importing Co., (Inc.)
Roessler and Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

Ceramic Plant Equipment
Chambers Brothers Co.
Mueller Machine Co., Inc.
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.

Clay (Ball)
Harshaw, Fuller & Goodwin Co.
Paper Makers Importing Co.
Potters Supply Co.
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay (China)
Drakenfeld and Co., B. F.
Edgar Brothers Co.
Harshaw, Fuller & Goodwin Co.
Paper Makers Importing Co., (Inc.)
Roessler & Hasslacher Chemical Co.
United Clay Mines Corp.

Clay (Electrical—Porcelain)
Edgar Brothers Co.
Harshaw, Fuller & Goodwin Co.
Paper Makers Importing Co., (Inc.)
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay (Enamel)
Edgar Brothers Co.
Paper Makers Importing Co.
Metal & Thermit Corp.
United Clay Mines Corp.
Vitro Mfg. Co.

Clay (Fire)
Edgar Brothers Co.
Paper Makers Importing Co., (Inc.)
Parker Russell Co.
Potters Supply Co.
United Clay Mines Corp.

Clay (Potters)
Paper Makers Importing Co.
Spinks Clay Co., H. C.
United Clay Mines Corp.

BUYERS' GUIDE (continued)

Clay (Sagger)
Edgar Brothers Co.
Paper Makers Importing Co., (Inc.)
Parker Russell Co.
Potters Supply Co.
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay Cleaning Machinery
Lancaster Iron Works, Inc.

Clay Handling Machinery
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.

Clay Miners
Edgar Brothers Co.
Paper Makers Importing Co., (Inc.)
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay Storage Systems
Lancaster Iron Works, Inc.

Clay (Wad)
Paper Makers Importing Co., (Inc).
Potters Supply Co.
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay (Wall Tile)
Paper Makers Importing Co., (Inc).
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay Washing Machinery
Mueller Machine Co., Inc.

Clay Working Machinery
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.

Cloth (wire)
Newark Wire Cloth Co.

Coal-(Bituminous)—
Seaboard Fuel Corp.

Colors
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Innis, Speiden & Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Conditioning Machinery
Philadelphia Drying Machinery Co.
Proctor & Schwartz, Inc.

Cones (Filter)
Norton Co.

Conical Mills
Hardinge Co.

Controllers
General Electric Co.

Conveyors (Belt Cable)
Lancaster Iron Works, Inc.

Conveyors (Clay, Sand, Brick, etc.)
Hadfield-Penfield Steel Co.
Philadelphia Drying Machinery Co.
Mueller Machine Co., Inc.

Controllers, (Automatic Temperatures)
Brown Instrument Co.
Engelhard, Charles, Inc.
Leeds & Northrup Co.

Cores (Alundum Furnace)
Norton Co.

Cornwall Stone
Harshaw, Fuller & Goodwin Co.
Pennsylvania Pulverizing Co.

Crucibles (Filter-Melting-Ignition)
Norton Co.
Potters Supply Co.

Crushers
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Hardinge Co.
Lancaster Iron Works, Inc.
Mueller Machine Co., Inc.

D

Decorating Supplies
Caulkins & Co., H. J.
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Decorating Kilns
Caulkins & Co., H. J.
Holcroft & Co.

Dental Furnaces
Caulkins & Co., H. J.

Discs (Alundum-Porous-Filter)
Norton Co.

Dishes (Alundum-Filtering-Ignition)
Norton Co.

Disintegrators
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Lancaster Iron Works, Inc.
Mueller Machine Co., Inc.

Dolomite
Innis, Speiden & Co.

Dryers (China Ware—Porcelain)
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.

Dryers (Steam Pipe Rack)
Lancaster Iron Works, Inc.

Drying Machinery
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.

BUYERS' GUIDE (continued)

E

Electrical Instruments
Brown Instrument Co.
Engelhard, Charles, Inc.
Leeds & Northrup Co.

Electric CO_2 Meters (Recorders)
Brown Instrument Co.
Engelhard, Chas., Inc.

Electrical Porcelain Machinery
Mueller Machine Co., Inc.

Enameling Equipment, Complete
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
The Porcelain Enamel & Mfg. Co.

Enameling Furnaces
Caulkins & Co., H. J.
Chicago Vitreous Enamel Product Co.
General Electric Co.
Holcroft & Co.
Parker Russell Co.
The Carborundum Co. (*Carboradiant*)
The Porcelain Enamel & Mfg. Co.
U. S. Smelting Furnace Co.
Vitro Mfg. Co.

Enameling Furnaces (Electric)
General Electric Co.

Enameling Muffles
Parker Russell Co.
The Carborundum Co.
(*Carbofrax*)

Enameling, Practical Service
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
The Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Enamels, Porcelain
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
The Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Engineering Service
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Parker Russell Co.

Equipment (Porcelain Enameling)
Chicago Vitreous Enamel Product Co
The Porcelain Enamel & Mfg. Co.

Extruding Machines (Lab. Use)
Chambers Brothers Co.

F

Feldspar
Drakenfeld and Co., B. F.
Eureka Flint & Spar Co.
Harshaw, Fuller and Goodwin Co.
Innis, Speiden & Co. (*Isco*)
Pennsylvania Pulverizing Co.
Roessler & Hasslacher Chemical Co.

Filtering Machinery
Mueller Machine Co., Inc.

Fire Brick
Parker Russell Co.
The Carborundum Co.

Flint
Eureka Flint & Spar Co.
Harshaw, Fuller & Goodwin Co.
Innis, Speiden & Co. (*Carrara*)
National Silica Co.
Pennsylvania Pulverizing Co.

Frit
Ferro Enamel Supply Co.
Porcelain Enamel & Supply Co.
Vitro Mfg. Co.

Fuel
Seaboard Fuel Corp.

Furnaces
Caulkins & Co., H. J.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
Holcroft & Co.
Parker Russell Co.
The Carborundum Co. (*Carboradiant*)
The Porcelain Enamel & Mfg. Co.
U. S. Smelting Furnace Co.

Furnaces (Electrical)
Engelhard, Chas., Inc.
General Electric Co.
Holcroft & Co.

G

Glazes and Enamels
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
The Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Granulators
Lancaster Iron Works, Inc.

BUYERS' GUIDE (continued)

Gold
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

H

Hearths
The Carborundum Co.
(*Carbofrax* heat treating)

Hygrometers (Electric)
Engelhard, Chas., Inc.

I

Impervite (Refractory and Hard Porcelain)
Engelhard, Charles, Inc.

Infusorial Earth
Innis, Speiden & Co.

Iron (Enameling)
American Rolling Mill Co.
The Mansfield Sheet & Tin Plate Co.
United Alloy Steel Corp.

J

Jiggers
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.

K

Kaolin
Edgar Plastic Kaolin Co.
Harshaw, Fuller and Goodwin Co.
Roessler & Hasslacher Chemical Co.
United Clay Mines Corp.

Kilns (china, decorating)
Caulkins & Co., H. J.
Holcroft & Co.

Kiln Castings
Lancaster Iron Works, Inc.

Kryolith
Harshaw, Fuller & Goodwin Co.
Pennsylvania Salt Mfg. Co.

L

Lehrs (Electric)
General Elec. Co.

Linings (Furnace-Refractory Block-Refractory Plate, Brick and Tile)
Norton Co.
The Carborundum Co.

M

Magnesite
Harshaw, Fuller & Goodwin Co.
Innis, Speiden & Co.

Manganese
Harshaw, Fuller & Goodwin Co.
Hy-Grade Manganese Co.

Metals (Porcelain Enameling)
American Rolling Mill Co.
The Mansfield Sheet & Tin Plate Co.
United Alloy Steel Corp.

Mills (*See under Ball Mills*)
(*See under Pebble Mills*)

Minerals
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Mixing Machines
Chambers Brothers Co.

Moulds (Brick)
Lancaster Iron Works, Inc.

Muffles (Furnace)
Norton Co.
The Carborundum Co. (*Carbofrax*)

Muriatic Acid
Harshaw, Fuller and Goodwin Co.
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.

N

Nitrates (Cobalt, Sodium)
Harshaw, Fuller & Goodwin Co.
Innis, Speiden & Co.

O

Oil Burners
Best, W. N. Corp.

Opacifiers
Harshaw, Fuller & Goodwin Co.
Titanium Alloy Mfg. Co.

Operators (Coal)
Seaboard Fuel Corp.

Oxides
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Innis, Speiden & Co.
Metal & Thermit Corp.
Paper Makers Importing Co., (Inc.)
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

BUYERS' GUIDE (continued)

P

Pans (Wet and Dry)
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.

Pebble Mills
Hadfield-Penfield Steel Co.
Hardinge Co.
Mueller Machine Co., Inc.

Pins
Potters Supply Co.

Placing Sand
Pennsylvania Pulverizing Co.
National Silica Co.
United Clay Mines Corp.

Plate Feeders
Chambers Brothers Co.
Hadfield-Penfield Steel Co.

Plates (Filter)
Norton Co.

Porcelain Enameling Service, Practical
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
The Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Porcelain Enamels
Chicago Vitreous Enamel Product Co.
The Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Potash (Carbonate)
Innis, Speiden & Co.

Pottery Machinery
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.

Pug Mills
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Lancaster Iron Works, Inc.
Mueller Machine Co., Inc.

Pulverizing Machinery
Hadfield-Penfield Steel Co.
Hardinge Co.
Mueller Machine Co., Inc.

Pulverizing Mills
Hadfield-Penfield Steel Co.
Hardinge Co.
Mueller Machine Co., Inc.

Pumps
Mueller Machine Co., Inc.

Pyrometers (Indicating)
Brown Instrument Co.
Engelhard, Charles, Inc.
Leeds & Northrup Co.

Pyrometers (Recording)
Brown Instrument Co.
Engelhard, Charles, Inc.
Leeds & Northrup Co.

Pyrometer (Switches)
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Pyrometer Tubes (Refractory and Hard Porcelain)
Brown Instrument Co.
Engelhard, Charles, Inc.
Leeds & Northrup Co.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.

R

Recording Instruments
Brown Instrument Co.
Engelhard, Charles, Inc.
Leeds & Northrup Co.

Recuperators
The Surface Combustion Co.

Refractories
The Carborundum Co.
Norton Co.
Parker Russell Co.
United Clay Mines Corp.

Refractory Materials
Parker Russell Co.
United Clay Mines Corp.

Regulators (Automatic Temperatures)
Brown Instrument Co.
Engelhard, Charles, Inc.
Leeds & Northrup Co.

S

Saggers
The Carborundum Co.
Norton Company
Potters Supply Co.

BUYERS' GUIDE (continued)

Sagger Presses
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.
Watson-Stillman Co.

Screens
Newark Wire Cloth Co.

Selenite of Sodium
Drakenfeld and Co., B. F.
Harshaw, Fuller & Goodwin Co.
Vitro Mfg. Co.

Shippers (Coal)
Seaboard Fuel Corp.

Silica Brick
Parker Russell Co.

Silex Lining
Hardinge Co.

Sillimanite (Synthetic)
Norton Co.

Slabs (Furnace)
Norton Co.

Smelters
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
Parker Russell Co.
U. S. Smelting Furnace Co.

Soda Ash
Harshaw, Fuller & Goodwin Co.
Innis, Speiden & Co.

Sodium Antimonate
Harshaw, Fuller & Goodwin Co.
Metal & Thermit Corporation
Vitro Mfg. Co.

Sodium Fluoride
Harshaw, Fuller & Goodwin Co.
Innis, Speiden & Co.

Spar
Eureka Flint and Spar Co.
Harshaw, Fuller & Goodwin Co.
Pennsylvania Pulverizing Co.

Spurs
Potters Supply Co.

Stacks
Lancaster Iron Works, Inc.

Stilts
Potters Supply Co.

Sulphuric Acid
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.

T

Tachometers
Brown Instrument Co.

Talc
Harshaw, Fuller & Goodwin Co.
Innis, Speiden & Co.

Tanks
Lancaster Iron Works, Inc.

Temperature Instruments (Measuring)
Brown Instrument Co.
Engelhard, Charles, Inc.
Leeds & Northrup Co.

Thermocouples
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Thermometers (Electric Resistance)
Brown Instrument Co.
Engelhard, Charles, Inc.
Leeds & Northrup Co.

Thimbles (Filtering Extraction)
Norton Co.

Tile Machinery (Floor and Wall)
Mueller Machine Co., Inc.

Tin Oxide
Harshaw, Fuller & Goodwin Co.
Metal & Thermit Corp.

Titanium
Titanium Alloy Mfg. Co.

Tubes (Insulating)
Engelhard, Chas., Inc.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.

Tubes (Pyrometer)
Brown Instrument Co.
Engelhard Charles, Inc.
Leeds & Northrup Co.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.

BUYERS' GUIDE (continued)

V

Vacuum Pumps
Mueller Machine Co., Inc.

W

Wet Enamel
Chicago Vitreous Enamel Product Co.
The Porcelain Enamel & Mfg. Co.
Ferro Enamel Supply Co.
Vitro Mfg. Co.

Whiting
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Innis, Speiden & Co.
Roessler and Hasslacher Chemical Co.

Winding Drums
Lancaster Iron Works, Inc.

Witherite
Harshaw, Fuller & Goodwin Co.
Innis, Speiden & Co.

Z

Zirconia
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

ALPHABETICAL LIST OF ADVERTISERS

(When writing to advertisers, please mention the JOURNAL)

CLASSIFIED ADVERTISING

CERAMIC BREVITIES

The Brown Instrument Co. announces the opening of a Los Angeles Branch at 363 New High Street, Los Angeles, Calif., with Mr. S. F. Godfrey, late of The Braun Corporation, as District Manager.

Articles of incorporation having been filed in California, this branch will carry stock and conduct its own accounting direct with its customers. Users of Brown Pyrometers, Recording Thermometers, Electric CO_2 Meters, Electric SO_2 Meters, Pressure Gauges, Tachometers, Draft Gauges, etc., will appreciate this new Branch Office.

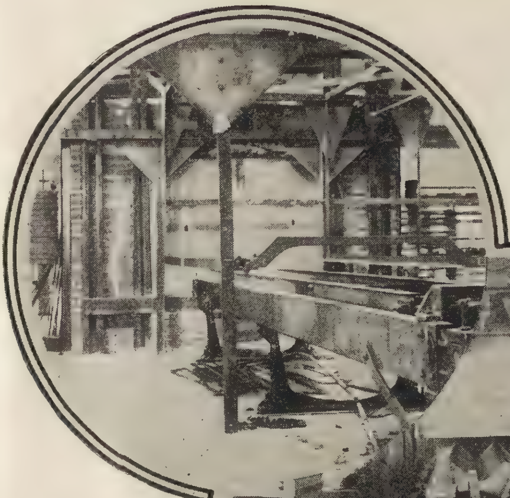
A complete Repair Department is maintained and customers are assured of thorough Brown Service in every way.

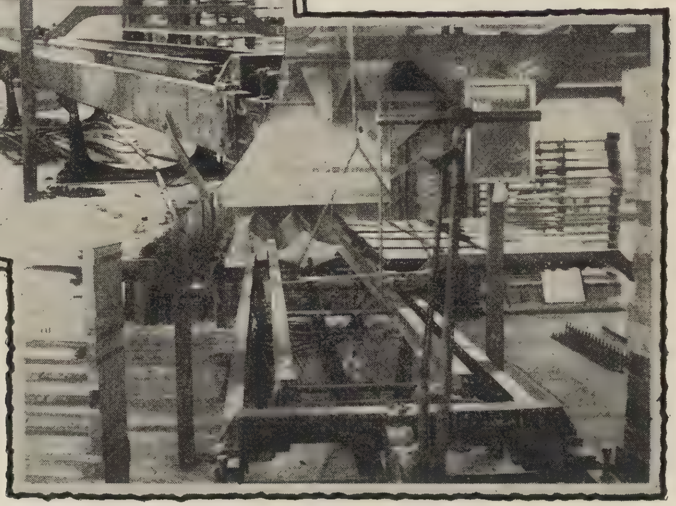
They also announce the opening of the following offices:
Indianapolis, Ind., 215 East New York St., Mr. J. R. Green, in charge.
Cleveland, Ohio, Room No. 1108 Hippodrome Building, Mr. G. S. Frazee, in charge.

THE WOLVERINE PORCELAIN ENAMELING COMPANY of Detroit, Michigan is planning further additions to the present plant.

Two furnaces, sixty inches wide by one hundred and eighty inches long and additional sand blast equipment will go into the new building which is being erected. Approximately One Hundred Thousand Dollars will be spent at this time.

The plant is operated under the management of the Porcelain Enamel and Manufacturing Company of Baltimore, Maryland, which company is successfully operating large plants in other cities throughout the United States.





Two views of an enameling furnace, one showing a load of stove panels (right) just after being drawn out. The fork at the left carries racks loaded with panels ready to be put into the furnace.

ALUNDUM ENAMELING MUFFLES

Alundum is electrically fused alumina produced in an electric arc furnace. Alundum muffle plates are mechanically strong, chemically inert, have high heat conductivity, and are for these reasons ideally suited for the construction of enameling furnaces.

Repeat orders for Alundum muffles like the one in the furnace shown on this page are the best evidence of satisfactory performance.

NORTON COMPANY, WORCESTER, MASS.

R–253

TRADE NORTON MARK